The Royal London

Ophthalmic Hospital Reports.

Vol. XV. Part II. May, 1902.

THE NERVE-SUPPLY OF THE LACRYMAL GLAND.

By J. Herbert Parsons, F.R.C.S.

It has generally been considered that the secretory nerve fibres to the lacrymal gland are derived from the fifth cranial nerve. Some observers, reasoning principally from the analogous salivary glands, have included the cervical sympathetic as an additional source of supply. More recently the view has been advanced that the true secretory nerve is the seventh and not the fifth.

The object of the present paper is to examine critically the evidence on the question from anatomical, histological, embryological, physiological, and pathological standpoints, to record some further observations, to point out some hitherto neglected methods of investigation, and to supply a bibliography of the most important papers upon the subject.

I. *Anatomy.*

The lacrymal nerve, derived from the first or ophthalmic division of the trigeminal, divides close to the gland into two branches. Of these, the upper is distributed in part directly to the gland, and partly passes out of the orbit to supply the skin of the upper eyelid, &c.; the lower branch communicates with the temporal branch (*ramus temporalis, subcutaneus malæ*, &c.) of the orbital or temporo-malar nerve,

which is derived from the second or maxillary division of the V, and is then distributed to the gland. Through this communication it is possible for fibres of the VII or of the nervus intermedius of Wrisberg to reach the gland, leaving the facial at the geniculate ganglion, and passing to the sphenopalatine (Meckel's) ganglion *viâ* the great superficial petrosal and Vidian nerves, and from the ganglion into the second division of the V, *viâ* the two spheno-palatine nerves.

That the communication with the orbital nerve is of some importance is shown by the occasional absence of the lacrymal, its place being taken by the orbital. On the other hand, the lacrymal has been known to supply the malar branch, which usually arises from the orbital. (Thane.)

It is thus obvious that purely anatomical considerations cannot settle the question.

II. *Histology.*

By means of the microscope the exact nature of the nerve fibres and their ultimate destination can be determined.

With regard to the latter point, Dogiel[1] has proved by the methylene-blue method that the fibrils are distributed in the same manner as in the case of the salivary glands. The nerve fibres which enter the gland are almost all non-medullated: they for the most part enter the lobules with the blood-vessels and ducts. They then form a plexus upon the basement-membrane of the alveoli. From this plexus fine branches pierce the basement-membrane, and form a network around the bases of the cells (Ueberzellennetz). Fine fibrils are given off from this network, penetrating between the epithelial cells, and there forming an intercellular network (Interzellennetz). Fibrils are sometimes seen which seem to end free, but Dogiel attributes this to incomplete staining. As in the case of other glands, it is doubtful if the fibrils ever actually enter the epithelial cells of the gland.

The cranial nerves have been especially the subject of histological investigation by Gaskell and his pupils. In the dog, the lacrymal is a branch of the second division of the V, and can thus receive fibres from the VII without the intervention of the subcutaneous malæ, with which it is said not to communicate. According to Edgeworth,[2] the lacrymal consists of "grey fibres and medullated fibres up to 16 μ in diameter." "The great superficial petrosal consists of grey fibres and medullated fibres up to 11·2 μ in diameter; it is a very small nerve, and contains but few fibres." It will thus be seen that it is impossible to demonstrate the passage of fibres of the VII or nervus intermedius into the lacrymal histologically, though the facts are not contradictory.

On the assumption that the lacrymal secretory fibres come from the great superficial petrosal, it is of interest to trace their origin from the brain. In the analogous case of the chorda tympani, which contains the secretory fibres for the submaxillary and sublingual glands, the fibres are derived from the nervus intermedius, which "is essentially a small fibred formation, with a few much larger fibres" (Gaskell[3]). The statement of Vulpian[4] that the chorda degenerates almost entirely after intracranial section of the V in rabbits, whilst it remains nearly intact after section of the VII in dogs, is opposed by the fact that the chorda contains far more medullated fibres than the great superficial petrosal, which is the only source from which it could receive fibres from the V in the tympanic part of its course. Moreover, according to the embryological researches of Dixon,[5] the great superficial petrosal grows out from the geniculate ganglion; and if this be true, the origin of its fibres, and therefore of the lacrymal secretory fibres, must be from the VII nucleus. On the other hand, Duval[6] claims to have traced the portio intermedia centrally to the upper end of the IX (glossopharyngeal) nucleus, in which case the origin of the chorda tympani, and probably also the lacrymal fibres, would be here.

III. *Embryology.*

The lacrymal gland arises from solid ingrowths of the conjunctival epithelium. The lacrymal duct is formed along the fissure which separates the lateral nasal process from the maxillary process, but its exact development is a matter of dispute ; so that even if this be taken as a guide to the morphological relations of the gland—an assumption peculiarly open to criticism in the case of this duct—we are still lost in the unknown pre-mandibular region. Moreover, the morphology of the cranial nerves is so beset with difficulties and pitfalls that we can expect no aid from this source in solving the question of the innervation of the lacrymal gland.

IV. *Physiology.*

Historical Résumé.—Petit (1727)[7] found increase of tears after section of the "nerf intercostal" (cervical sympathetic) in the dog. Langley[8] attributes this to the hyperæmia of the gland due to paralysis of the vaso-constrictors, leading, as in the salivary glands, "to a greater secretion than normal whenever secretion is in any way set up." The fact has been confirmed by Arloing[9] in the deer and ox.

Czermak (1860)[10] obtained secretion from stimulating the V trunk, but in such a manner that it might be a reflex effect.

Herzenstein (1867)[11] obtained a positive effect from the lacrymal in sheep, dog, and rabbit, and a variable effect from the sympathetic.

Wolferz (1871)[12] confirmed Herzenstein's results, and also obtained an effect from the subcutaneous malæ. This can hardly be reconciled with the fact that the subcutaneous malæ does not communicate with the lacrymal in the domesticated animals.

Demtschenko (1871)[13], Tépliachine (1894)[14], and Tribondeau[15] also confirm Herzenstein, but the method used is open to the severest criticism. The outflow of tears was

apparently so small as only to be appreciated by pieces of filter-paper (Fliesspapier) placed in the conjunctival sac. The mere reflex effect induced by such irritation might account for the result.

Reich (1873)[16] performed 86 experiments upon rabbits, cats, dogs, and sheep in E. Brücke's laboratory. He found (1) that stimulation of the peripheral end of the V root causes no effect; (2) that reflex secretion can still occur after section of V intracranially; (3) that stimulation of the lacrymal nerve peripherally causes a flow, and that no reflex effect follows section of the lacrymal; (4) that stimulation of the cervical sympathetic causes a doubtful effect, whilst reflex effects may occur after section of V together with extirpation of the superior cervical ganglion; (5) that the secretory fibres do not come from the IV nerve; (6) that reflex flow may occur after tearing out the VII nerve. From (2) and (3) it is obvious that the lacrymal nerve in these animals contains secretory fibres which do not come from the V. In (6) the nerve was apparently torn out from the stylo-mastoid foramen, in which case the upper part, including the connection with the great superficial petrosal nerve, might very well have escaped injury. Reich's experiments are probably the most exhaustive and most careful hitherto recorded.

Vulpian and Journiac (1879)[17], in the rabbit, using curare (which is said to stimulate lacrymal secretion) and artificial respiration, stimulated the cavum tympani and obtained a flow of tears, and of a milky fluid at the inner canthus. The latter is derived from the Harderian gland. In two animals the whole of the intracranial part of the left VII was extirpated some days before, and much less result followed stimulation than on the right side.

Bechterew and Mislawski (1891)[18] found integrity of the V unnecessary for reflex effect. They affirm the "undoubted influence of the cervical sympathetic." They also obtained an outflow of tears from stimulation of the optic thalamus, which they regard as the reflex centre, and of the cortex,

especially in the neighbourhood of the sigmoid gyrus. They paid no attention to the VII nerve, and regard the V and the cervical sympathetic as the secretory nerves.

Laffay (1896),[19] as the result of intracranial section of the VII in the dog and repetition of the older experiments regards the VII as the secretory nerve.

Campos (1897)[20] describes at length a single experiment, in which he divided the great superficial petrosal in the monkey, and still obtained a diminished effect upon stimulating after time had elapsed for degeneration. From his description I should consider it doubtful whether he divided the nerve.

I have performed several experiments upon cats, dogs, and rabbits in which I have stimulated the lacrymal nerve, the subcutaneous malæ, the tympanic plexus, the VII intracranially, the V intracranially, and the cortex cerebri. In no case can one obtain a sufficient outflow of tears as to cause them to overflow on to the face. In over 20 experiments in which I have stimulated the cortex cerebri in cats for another purpose,[21] I have never obtained an undoubted secretion of tears.

Professor Schäfer[22] has shown that activity of the gland causes microscopic changes in the cells similar to those found in the serous salivary glands. These results, he tells me, were obtained by injecting pilocarpine. I have examined the gland after stimulating the lacrymal nerve for an hour and a-half, the dog being anæsthetised the whole time with A.C.E. mixture. The gland was hardened in Flemming's chromic-osmic mixture, and cut by freezing microtome. There were slight changes in the cells pointing to activity, but they were not marked.

The best result which I have obtained was in repeating Vulpian and Journiac's experiment in the rabbit. In the cat, I found that this experiment was accompanied by marked dilatation of the pupil, and it is noteworthy that Demtschenko obtained the milky Harderian gland secretion after stimulating the cervical sympathetic. Vulpian and

Journiac's degeneration experiments, however, seem to prove that the sympathetic cannot account for the whole effect. I have also found that stimulation of the cervical sympathetic is accompanied by blanching of the conjunctiva, whilst stimulation of the tympanic plexus usually gives vaso-dilator effects.

It is obvious, I think, that no conclusive result is likely to follow further research upon these lines. I would suggest the following experiments, which I hope to carry out at a future date :—

(1.) Intracranial section of V and examination of the lacrymal nerve, and the gland by the methylene-blue method after time has been allowed for degeneration.

(2.) Intracranial section of VII and similar examination of the lacrymal nerve and gland. Part of the nerve should be teased, and the remainder stained with osmic, and cut in paraffin, and compared with the intact nerve of the opposite side.

(3.) Examination of the electrical variations of the gland on stimulation of the various nerves mentioned, and comparison of the results with those obtained by Bayliss and Bradford[23] in the case of the salivary glands.

(4.) Further microscopic examination of the cells after prolonged stimulation of the nerves electrically.

V. *Pathology.*

Paralysis of VII.—Jonathan Hutchinson (1876),[24] "Paralysis of the Portio Dura of the right side, with deafness occurring suddenly. Paralysis of lacrymal gland, and temporary paralysis of lower extremity on same side. Slight defect of sensation on same side of face. No pain."

The patient was a woman, æt. 34. The paralysis came on two days after confinement.

Goldzieher (1876),[25] woman, 26. R. eye, episcleritis with iritis. L. eye normal. Complete paralysis of L. VII with lagophthalmos. Skin of L. side of face hyperæsthetic after

electrical treatment. Syphilis excluded. Woman wept whilst under observation, and frequently afterwards. L. eye remained quite dry. Tears returned on L. side when the paralysis passed off, and have since been quite normal.

Uhthoff (1885),[26] woman, 25. R. trigeminal neuralgia and paræsthesia of second division of V. Tears only from L. eye when she wept, which she frequently did with the pain. Diagnosis: neuritis, with paresis of VII fibres in maxillary nerve.

Goldzieher (1894), woman, 21. Congenital complete paralysis of L. VII with lagophthalmos. Sensation of skin of face and bulbus normal. Tears only on normal side since birth.

Jendrássik (1894)[27] (1) woman, 43. Complete paralysis of L. VII with lagophthalmos. No loss of sensation. Paralysis of lacrymal gland on L. side.

(2) Woman, 54. Complete paralysis of L. VII and of palate. Sensation normal. Less reddening of conjunctiva, and no tears. Recovered with recovery of facial paralysis.

(3) Woman, 44. Similar to (2).

(4) Woman. Incomplete paralysis of L. VII coming on 15 days after confinement. There were intermittent spasms, accompanied by flow of tears from L. eye only.

Jendrássik gives a very careful and minute account of the cases, but attaches too great importance to the paralysis of the palate considering our knowledge of its innervation.

Irritation of VII.—H. Schüssler (1879),[28] Actor's Cramp. Stretching of VII. Recovery. During violent stretching of VII an eggspoonful of tears gushed out of the eye on the same side.

Lumniczer,[29] another similar case.

Extirpation of Gasserian Ganglion.—Fedor Krause (1893).[30] After the operation neither more nor fewer tears flowed on one side than the other.

Horsley (1901)[31] writes: "The only point *re* lacrymation is that the hyperlacrymation ceases. I confess I have not examined the mucous membrane carefully to see whether

there is any *defect* of secretion. No patient has made any complaint about this." This is of great importance, considering Professor Horsley's wide experience of these cases.

It should be pointed out that complete paralysis of the VII is comparatively rare, the lesion in the majority of cases being at the stylomastoid foramen. In these cases the great superficial petrosal is not involved, and we should expect the secretion of tears to be normal. Indeed, many cases of lagophthalmos are accompanied by Stillicidium lacrymarum, the outflow of tears being particularly evident owing to the immobility of the lower lid. We must further bear in mind the possibility of a paralytic secretion analogous to that described by Langley for the salivary glands.

In conclusion, while the question cannot be considered settled, there is yet a sufficient amount of evidence in favour of the facial nerve being the secretory nerve of the lacrymal gland to cast much doubt upon the generally received view in favour of the trigeminal.

[The experiments were performed in the Physiological Laboratory, University College, London.]

BIBLIOGRAPHY.

(1.) Dogiel. Archiv f. Mikr. Anat., xlii, s. 632.
(2.) Edgeworth. Journ. of Anat. and Phys., xxxiv, p. 113.
(3.) Gaskell. Journ. of Phys., ix.
(4.) Vulpian. Gaz. Méd. de Paris, 1878.
(5.) Dixon. Trans. Roy. Dub. Soc., series ii, vol. iv.
(6.) Duval. Quain's Anat., vol. iii, pt. ii, p. 252.
(7.) Petit. Hist. de l'Acad. Roy. des Sc., 1727.
(8.) Langley. Schäfer's Text-book of Physiology, ii, p. 619.
(9.) Arloing. v. Campos, Arch. d'Ophthal., xvii.
(10.) Czermak. Moleschott's Untersuchungen, 1860, vii, s 379.
(11.) Herzenstein. Beiträge z. Phys. u. Ther. der Thränenorgane, Berlin, 1868 (v. Journ. Anat. and Phys.. ii, p. 413).
(12.) Wolferz. Exp. Untersuch. ü. die Innervationswege der Thränendrüsen, Dissert. Dorpat, 1871.
(13.) Demtschenko. Dissert. Petersburg (Russian), 1871 ; v. Pflüger's Archiv, 1872, vi, s. 191.
(14.) Tépliachine. Arch. d'Ophthal., 1894.

(15.) Tribondeau. v. Campos.
(16.) Reich. Graefe's Archiv f. Ophth., 1873, xix, s. 38.
(17.) Vulpian et Journiac. Comptes Rendus de l'Acad. fr., 1879, lxxxix, p. 393.
(18.) Bechterew und Mislawski. Neur. Centralbl., 1891, x, s. 481.
(19.) Laffay. Thèse de Bordeaux, 1896; v. Revue des Sc. Méd., 1897, l, p. 10.
(20.) Campos. Comptes Rendus de la Soc. de Biol., 1897; Arch. d'Ophthal., xvii, p. 529.
(21.) Parsons. Brit. Med. Journ., 1900, ii, p. 738; Jl. of Physiology, xxvi, p. 366.
(22.) Schäfer. Quain's Anat. vol. iii, pt. iii, p. 8.
(23.) Bayliss and Bradford, Proc. Roy. Soc., No. 243, 1886; Internat. Monatsschrift f. Anat. u. Phys., 1887, iv.
(24.) Hutchinson. Ophth. Hosp. Reports, viii, 1876.
(25.) Goldzieher. Archiv f. Augenheilkunde, xxviii, 1894.
(26.) Uhthoff. Neur. Centralbl., 1885.
(27.) Jendrássik. Revue Neurol., 1894, p. 186.
(28.) Schüssler. Berlin Klin. Wochenschrift, 1879.
(29.) Lumniczer. v. Goldzieher.
(30.) Krause. Deut. Med. Woch., 1893.
(31.) Horsley. Private Communication.

A CASE OF SYMPATHETIC INFLAMMATION AFFECTING THE POSTERIOR PART OF THE UVEAL TRACT.

By J. Herbert Fisher, M.B., B.S. (Lond.), F.R.C.S., Assistant Surgeon to the Hospital, Assistant Ophthalmic Surgeon to St. Thomas's Hospital, &c.

Of all the varieties of eye disease which have from time to time been classed as sympathetic, we may, I think, at the present day recognise two main classes. With the larger class, sympathetic iridocyclitis, every ophthalmic surgeon is, alas! too familiar; the plastic character of the inflammatory process, its intractability and often disastrous results, are well known to all; instead of the more usual terms, some authors refer to such cases as sympathetic irido-choroiditis. The other class forms quite a small proportion of the total number of recorded cases of sympathetic disease. The examples of this smaller class, as far as I have been able to find them, are invariably called cases of neuro-retinitis or papillo-retinitis. In the exhaustive and very valuable Report of the Committee of the Ophthalmological Society of the United Kingdom, published in the Transactions, 1886, vol. vi, eight or nine cases of this variety of sympathetic inflammation are reported, all under one or other of these designations. The case by Colsmann, there included and originally published in the Berlin Klin. Wochenschr., 1877, the Committee regarded as doubtfully of sympathetic origin, as it took the form of neuro-retinitis only, and they had doubts also about one or two others. The prognosis in these cases was found to be far better than in those belonging to the larger class; nearly all recovered quite good vision, and the observation is made that this favourable result seems to occur whatever the interval between the dates of injury to the exciter and onset in the sympathiser may have been. I have been able to find reports of a few other cases; the recovery of vision in nearly all of them seems to be quite remarkable. I find them invariably entitled cases of neuro-

retinitis or papillo-retinitis by their authors; they are never referred to as cases of sympathetic uveitis or choroiditis. In some, however, definite choroidal change is described by the reporting surgeon, though he regards this as of subsidiary importance, *e.g.*, V. Graefe (Arch. für Ophthalmol., xii, ii, 171). The left eye was operated on for extraction of a calcified lens; six weeks later rapid painless failure of sight occurred in the right eye, due to diffuse retinitis; this was followed by keratitis punctata and paralysis of accommodation. Two and a-half months from the onset the vision had improved to $\frac{4}{5}$; disseminated spots of choroidal disease appeared towards the end of the case. A case reported by Krause (Hirschberg Centralbl., 1881, p. 7) seems to belong to the common variety of sympathetic disease, but choroiditis patches were noted in the lower part of the fundus of the sympathising eye. Galezowski (Traité d'Ophthalmoscopie, 1886, p. 202) reports two cases that he had under care, and calls them cases of sympathetic lesion of the retina; in each, however, he says the choroid had undergone at the same time change in various places in the shape of obvious disseminated atrophic patches. Such spots of choroidal atrophy he was inclined to think were due to pressure of blood, and from the context it was the blood poured out in the retina to which he referred. Such a cause for the formation of spots of atrophy in the choroid coat is new to me, and I must confess does not seem to me very probable. I am not aware that spots of retinal hæmorrhage from other causes on clearing are in the habit of revealing areas of atrophied choroid. This then is the class of case on which those who argue for the transmission of the existing cause of sympathetic inflammation by the route of the optic nerves and chiasma rely, while cases of the more ordinary variety occasionally also present changes at the disc. The Committee of the Ophthalmological Society came to the conclusion, however, that the fact of papillitis showing itself did not prove transmission by the optic nerves, as it was often present in simple cases of serous iritis. The rarity of papillitis in cases of

sympathetic inflammation is a point advanced by the opponents of Deutschmann's theory, but with the conflicting views I do not propose to deal.

When the case which I here report came under my care I was not so well acquainted with the literature of this variety of sympathetic disease as I have since been able to make myself, and I was in the habit of referring to my case as one of sympathetic uveitis, in which the most posterior segment of the uveal tract was bearing the brunt of the disease. This seemed to me to be the natural view to take, and I must say what I have since learnt has not as yet led me to acquiesce in the more general view. It seems to me improbable that at one time the sympathetic influence shall direct all its energy to the iris and ciliary region, while at another time it will leave the uveal tract severely alone and select the retina and disc for its operations.

All the cases, including my own, have in the active stage and over a long period been accompanied by a quite alarming reduction of vision, while the recovery of function has not been less remarkable. In my own case the vision was reduced to the ability to count fingers at 2 or 3 feet, and that only by eccentric fixation, and the patient was under my care and observation for two months before any definite improvement in the sight could be detected, though repeatedly tested. During all this period, and for long after, there was very active pathological fundus change. I doubt if any retina or optic nerve could be in so active a condition of inflammation for many months and the eye eventually recover full direct vision and a full field as my case did, with no sign of atrophy at the optic papilla. Another point which much interested me, and to which I think much weight may be attached, is the fact that there was very definite reduction of tension in the affected eye; this is a point about which there was no doubt whatever; observations were repeatedly made and recorded by the house surgeons and myself. On admission the tension of the sympathising eye was normal; soon it became reduced;

a fortnight after onset it was −1; very gradually it improved. I was in the habit of saying to students that I considered this fall in tension as showing that the vascular uveal tract was performing its nutritive duties imperfectly to the vitreous and aqueous humours of the eye as well as to the retina. As the result of the softening of the eye, I pointed out that the globe was squared by pressure of the recti muscles, and when the tension began to show signs of improvement I held this to be the first good sign, and was hopeful that before long the retina also would be better treated by its nourishing coat and show some improvement in appearance and recovery of function, and this subsequently took place. I regarded the choroid as being in a state of diffuse inflammation, and the changes in the retina and at the optic disc I think can be sufficiently accounted for as œdema secondary to the disturbance of its nourishing tunic. If it is argued that in the end the choroid showed no change on ophthalmoscopic examination, the argument applies, I think, with still greater force to the retina if any one is inclined to say that retinitis was the main feature. I conceive it is possible for such a coat as the choroid to be diffusely inflamed and to be left generally somewhat sclerosed without the change being conspicuous on ophthalmoscopic examination. In this condition the chorio-capillaris might still retain a sufficiently free circulation to allow the retina which it helps to nourish to regain its function to the full. A severe primary retinitis is rarely so devoid of retinal hæmorrhage as mine was.* It is not likely to cause reduction in tension in the eye, to continue for many months with com-

* My patient showed one very minute streak of retinal hæmorrhage, found towards the end of the case. Galezowski's patients appear to be two in whom retinal hæmorrhages were present; in none of the others to which I have been able to refer is any mention made of blood extravasation in the retina. It is only to be expected that with turgid retinal veins from obstruction by a swollen optic disc hæmorrhage would occasionally be seen; it is hardly to be believed that so many cases can be accurately described by the term sympathetic retinitis, when in the great majority no retinal hæmorrhages can be found; distended veins are observed in nearly all of them.

plete recovery of vision, and to leave practically no ophthalmoscopic change.

No one will, I think, deny the sympathetic character of the disease. The boy had always had perfect health; there was nothing in his appearance to suggest congenital syphilis; his father, mother, and eight other children were all living and enjoyed good health; the patient was carefully examined while in hospital and all organs found to be healthy. The most anterior part of the uveal tract did not quite escape; the iris at first was muddy; two posterior synechiæ had formed, but gave way gradually to mydriatic till the pupil was quite round; there was slight keratitis punctata only, but a punctate deposit of brownish and grease-like spots, identical with those seen on the back of the cornea, was abundantly present on the anterior lens capsule, and frequently examined with the pocket magnifier; there was also fine vitreous opacity.

H. B., æt. 18, baker, was sent to St. Thomas's Hospital by his doctor on January 9, 1899, with the following history:— Six weeks before admission, when attempting to find his way out of a dairy in the dark, he struck the left eye against the latch of a door. The same evening he went to his doctor and remained under his care. By Christmas week the injured eye had become quiet, and he returned to work. On December 27, 1898, he was taken ill with pains in the head, and also expectorated blood, mixed with phlegm. His doctor again saw him the next day and diagnosed influenza, but the symptoms do not appear to have been very marked. At the onset of the influenza the left eye again became inflamed, and remained so until I saw him; its vision did not recover at all after the accident. The right eye first became inflamed five days before admission to hospital; its vision began to fail at the same time, and continued to get worse. Belladonna lotion had been used to the left eye throughout, and to the right also, from the time it began to show symptoms.

To his family and personal histories I have already alluded; it is sufficient here to say that both are perfectly good and against any form of constitutional inheritance.

On admission to hospital the right eye showed conjunctival and slight ciliary injection. Cornea clear. Iris rather muddy. Pupil moderately dilated. Tension normal. V. = counts fingers at 1 metre. Oph: O. D. muddy, and edges quite obscured; general œdema of retina, but no cherry-red spot at macula; veins very much swollen; no material alteration in size of arteries; no hæmorrhages. Left eye: conjunctival and ciliary congestion. Scar at upper margin of cornea and extending in sclera. Iris above tucked back, simulating a coloboma. Iris muddy. Pupil moderately dilated. Some opacity of lens. No fundus reflex. T. −. Shrinking pain on pressure in ciliary region. V. = hand shadows.

The urine was normal, and all thoracic and abdominal viscera healthy. Mr. Lawford kindly saw the patient with me, and we agreed that the case was one of sympathetic disease of the right eye, and that the left should be excised. I accordingly removed the injured eye three days after admission; in the meantime no material change had occurred in the right. He was taking small doses of Hydrarg. c̄ cretâ, and atropine was being used.

On January 16 I found the right eye rather less congested, but it flushed on exposure to light. The cornea was clear. The pupil now well dilated and circular; the iris brighter; two small posterior synechiæ were obvious at the temporal part of the papillary margin. T. = −1; V. = fingers at 5 feet.

January 18. I noted fine dotted deposit on the anterior lens capsule, none on the back of the cornea; a little, but not much, fine opacity floats in the vitreous. Fundus now is a good deal more obscured; reflex rather greyish-red. Optic disc and retina give the same impression as before, but are by no means so clearly seen.

January 27. Pupil now wide and circular. T. still −. No pain. Abundant dotted deposit quite like that of keratitis punctata, but situated only on the anterior lens capsule, and chiefly on its inner sector; fine deposit in vitreous. Vision not appreciably improved. Fundus dimly visible; no outline of optic disc can be seen; distended tortuous veins everywhere; no localised choroidal exudation discoverable, but a general infiltration of this coat is suggested by the ophthalmoscopic appearances. I ordered two leeches to the right mastoid region.

On February 1 I stopped the Hyd. c̄ cretâ which he had been taking, and substituted a mixture of Pot. iod., with salicylate of soda and liquor ammonii acetatis, and ordered him a subcutaneous injection of nitrate of pilocarpine every other night. The pilocarpine was used in doses of gr. $\frac{1}{10}$th, and the dose never needed to be increased; he tolerated it very well; it produced profuse diaphoresis, and was continued until March 2. After this date small doses of Donovan's solution were prescribed; atropine was of course used throughout.

On February 8 I made the following note: "Still much dotted opacity on anterior surface of lens; none made out on back of cornea. Vitreous is clearer, but still shows floating opacity; some of this is cobwebby and larger than I have seen in this patient before. Fundus is much more clearly seen than at last note. Edges of optic disc quite lost; slight swelling of papilla, I think about 2·5 D. Veins turgid; in peripheral parts of retina are to be made out small circular dead-white dots, not glistening; the whole retina is hazy and œdematous; no hæmorrhages. V. = counts fingers at 6 or 8 feet; this he does by eccentric fixation, turning the eye up to count fingers held on my coat. T. is improving, but is still slightly reduced. He finds his way about readily, *e.g.*, in and out of the dark room, and collides with nothing. He stands the pilocarpine well, and the $\frac{1}{10}$th gr. has not yet had to be increased."

The next extract is my note of February 22, which reads as follows:—

"Two or three small grey dots of keratitis punctata on back of cornea; the pigmented dots on anterior lens capsule are less numerous. Cobwebby vitreous opacity still renders the whole fundus hazy; retina and optic disc are both œdematous, the former especially in its lower part. No hæmorrhages seen. I find less of the white dots in the fundus to-day than a fortnight ago; some are still, however, present; one, in the nasal half of the fundus, is crossed by one of the inferior nasal vessels. The eye is practically quite quiet, not flushed or photophobic, and its tension is certainly improved—indeed, very little below normal."

On February 27 the house surgeon recorded again his observation of keratitis punctata and noted, "tension normal," to which I agreed. From this date the tension kept normal, but

the globe remained squared by pressure of the recti muscles for some months. On March 2 the patient thought vision was better; said he saw better in twilight; still fixed eccentrically.

The next note I will quote is that of March 15. "Will count fingers at nearly 6 yards to-day, but not read any letter on Snellen's types. No longer any keratitis punctata to be made out, and on the anterior lens capsule there are only two or three dots of brown iris pigment, and no deposit from the ciliary region. Vitreous haze has practically all cleared, and fundus details are in every way much more distinct. Œdema of lower half of retina has nearly vanished; to outer side of inferior vein I see a group of circular exudation spots; the others found mostly in nasal half remain unpigmented and brightly glistening; optic disc is still swollen 3·0 D.; its outline streaked; no hæmorrhages. Vessels of good size; physiological cup remains a very obvious funnel. Tension normal."

On March 22 I observed a small area of mottled change at the macula and a suggestion of redness like that seen in embolus cases in the acute stage. A week later I found one quite short streak of hæmorrhage in the retina about one disc's breadth above the yellow spot. On April 5 the spot of hæmorrhage was still present, and vision, under atropine, with + 0·75 D. sph. = 6/36, one letter of 6/24, and this seemingly by central fixation.

On April 8 I discharged him from the ward, wearing goggles, and taking with him atropine drops.

On May 3, in the out-patient room, the eye with + 1·0 D. sph. saw 6/12 partly. The disc was still slightly swollen. I need not quote the full ophthalmoscopic note. I put him on quinine and iron.

On May 31 V. was 6/12 with + 0·75 D. sph., not 6/9. The swelling of optic disc was nearly subsided; the outline and surface brighter and sharper, but the former still radiate and softened. A good deal of patchy pigment disturbance near the macula and between this and the disc. The white circular dots found chiefly in the nasal portion of the fundus show slight pigmentation, and one at least is distinctly behind a retinal vessel. Goggles and mydriatic were abandoned.

September 6. "Says the sight has got much clearer. Is at work, driving a pony and trap. Vision to-day is 6/6 in a dull

illumination. Field for white taken on the perimeter quite full. Optic disc normal. Some white spots apparently going to remain permanently in the upper and nasal parts of the retina; the macular region shows so speckled an appearance one would not expect the eye to see 6/6ths, as it does. Tension normal."

The following report on the condition of the exciting eye was furnished me by Mr. Devereux Marshall, and my best thanks are due to him for his very careful examination :—

"There appears to be a coloboma upwards. Eye opened in an equatorial direction. There is some infiltration of vitreous, starting from a point where there has been a wound. The retina is wrinkled, and on one side, the lower, there is extensive retinal detachment, beneath which there is much coagulated albuminous material. Optic disc somewhat swollen and indistinct.

"*Microscopical Examination.* — The wound at the corneo-scleral junction is plainly visible, and apparently the ciliary body has been carried away from its attachment and has allowed the iris to be turned backwards between it and the sclera. Although the iris cannot definitely be seen it is surmised the above must be the explanation of the coloboma-like appearance, as some pigment lies between the sclera and the ciliary body, which is probably iritic in origin. The angle on the opposite side is closed, and the iris is thickened, inflamed, and its vessels enlarged. The ciliary body is intensely inflamed, so also is the choroid and retina. The lens is *in situ* and but little affected, though it is drawn somewhat out of shape near the ruptured sclera. The back part of the eye shows very marked changes. The choroid is about six times its normal thickness, and composed of masses of small round cells with large vessels; much pigment scattered through it. At one spot near disc the retina and choroid are firmly adherent. The optic disc is somewhat swollen, and there are collections of small round cells in it. The substance of the nerve does not seem to be affected. Cross-sections of the nerve show some inflammatory changes about the sheath, but the nerve is unaffected, *i.e.*, there is no proliferation of nuclei, &c. The fibres are indistinct and appear swollen. Vessels are much enlarged and distended with blood. Numerous small vessels run through the nerve in all directions."

REFERENCES FOR THE PURPOSES OF THIS PAPER.

Transactions of the Ophth. Society of the United Kingdom, 1886, vi, 170–291.

Louvet, Alfred. Pathogenie et Formes Cliniques de l'Ophthalmie Sympathique, Paris, 1889.

Abadie. Arch. d'Ophthalmologie, Paris, 1889, ix, 451–453.

Burnett, S. M. Arch. Ophth., New York, 1892, xxi, 254–256.

Rogman. Anns. d'Ocul, N.Y., 1895, cxiv, 81.

Adolf Arlts' paper before the International Ophthalmological Congress 1876.

Galezowski. Rec. d'Ophth., Paris, 1877, s. 2, iv, 358–360; *ibid.*, 1880, s. 3, ii, 641–654; *ibid.*, 1892, s. 3, xiv, 30–33.

Harlan, G. C. American Journ. Med. Sc., Philadelphia, 1879, lxxvii 383–390.

Pooley, J. R. Arch. Ophth. and Otol., N.Y., 1871–2, ii, 284–292.

Colsmann. Berlin Klin. Wochenschr., 1877.

Krause. Hirschberg's Centralbl., 1881, 7.

V. Graefe. Arch. für Ophthalmol., xii, ii, 171.

Galezowski. Traité d'Ophthalmoscopie, 1886, 202.

CASES AND OBSERVATIONS,

By E. Nettleship.

I. On Attacks of Temporary Blindness from Exposure to Cold Wind.

Case 1.—The Rev. —— (26.123) came to me in November, 1892, when æt. 43, about reading-spectacles, and gave the following history:—He usually spent his August holiday in Switzerland, often ascending some of the high passes. The first time he did any high climbing, about 6 years ago, when going in the teeth of a cold wind over a pass 10,000—12,000 feet (3,000—4,000 metres) high in perfectly clear weather, he became rapidly almost blind of both eyes for some time. It was like an extremely thick white fog; he was unable to see his feet, and the guides had literally to place his feet for him, or he would have missed his steps. As soon as the party were over the pass they were protected from the wind; his sight then began to improve, and was soon restored perfectly.

An exactly similar attack occurred another year in similar circumstances, but this time vision did not become quite clear till he had had a night's rest.

Again in August, 1894, in ascending the Rothhorn against a cold wind, he suffered for a third time in the same way. I had asked him to notice particularly how the defect of vision began, and he told me that on this occasion he noticed first broad rainbow fringes on each side of the rope, and next a mistiness between him and the ground, so that he began to think he should again lose sight of his feet. The attack came on shortly before they reached a certain rock shelter, which, though near the top, was protected from the wind. The symptoms passed off on reaching this shelter, and did not return when he descended the other side, "but the wind was not then in our faces." He was wearing goggles, as he always does when mountaineering, and had also taken the precaution to protect his head with a thick woollen wrap. The attack came on about 8 o'clock A.M., between the first breakfast and the second. He

had been at the Riffel Alp Hotel for a day or two before making this ascent, and it was there that, on the following day, he gave me the account of this last attack; he had been in Switzerland, lower down, for a fortnight before. He told me he had never in any of his climbs been troubled by giddiness, faintness, or difficulty of breathing at high altitudes.

The attacks never happen except when facing a cold wind on the Alps, and he is convinced that the loss of sight is the result of the cold wind upon his eyes. It was not the effect of snow dazzling, for he always used goggles, and, moreover, on the last occasion (1894) he was on dark rock free from snow when the dimness came on, though snow had been traversed lower down.

He has always been "a chilly subject," likes to wrap up warmly, is spare, with congested cheeks and nose, and very cold feet, is liable to chilblains on the ears (though not on hands or feet), but never has "dead fingers." He is subject to hay fever. He has the sort of ocular irritability that is shown by dislike of separate lights in a room, and always reads with a shaded lamp; but diffuse daylight, however strong, does not annoy him. He uses the microscope for studying minerals, and believes that polarised light tires his eyes more than ordinary light. Though, as stated, he has never had a real attack of dim vision except on the high Alps, he has several times had slight appearances of the same mistiness when facing cold wind even in England. There is no history of rainbows or evening mists suggestive of glaucoma. He has never had snow conjunctivitis.

I found he had full V. with slight H. As., and required

+ 0·75 D. s. + 0·5 D. c. for reading.

In each eye the lower retinal vein crossed its companion artery at the disc and showed spontaneous pulsation, there being no pulsation in other veins, which did not cross arteries. In the R. retina below O. D. were a considerable number of Gunn's dots ("Crick dots" of Mr. Marcus Gunn),* but I could see none in the L. He counted his R. as slightly the better eye for microscopical and other accurate work.

* Marcus Gunn: "Peculiar Appearance in the Vicinity of the Optic Disc occurring in Several Members of the same Family," Transactions of Ophthalmological Society, vol. iii, p. 110, 1882.

Case 2.—Arthur C., 25, told me in February, 1900, that for some two or three years he had been subject to attacks of "blindness" in his R. eye, lasting from half an hour to an hour, less or more. The attacks never came on except when he was driving in cold weather combined with a high wind (his work is to drive a tradesman's cart in a very exposed district 800 feet above sea-level). The appearance was as of a thick white mist before the eye, not actual darkness; it was so dense that if he shut the other eye he could see no objects at all with the affected one. He prefers to shut the affected eye when the attack comes on, but asserts repeatedly that "the dimness is there just the same whenever I open it." There is no pain or inflammation. When he gets into the house and gets warm the sight returns to its ordinary state.

The eye in question (R.) is not quite so good as the other owing to an old nebula of cornea running downwards from the level of the lower border of the pupil, which has the aspect of old interstitial keratitis. The L. cornea is normal. Fundus pupil and tension quite normal in both eyes. His physiognomy was suggestive of inherited syphilis. He could give no account of previous inflammation of the R. eye in explanation of the nebula.

It is probable that the keratitis was associated with a permanent change in the arterial coats of the choroid and retina of this eye, which, though not noticeable to ophthalmoscopic inspection, impaired their elasticity as compared with the vessels of the other (healthy) eye.

In the above cases the failure of sight had not the characters of the temporary blindness sometimes seen in persons with cardiac disease, and believed to be the expression of obstruction—as temporary as the loss of sight—in the arteria centralis by embolism or by thrombosis, perhaps aided by embarrassment of the blood-stream due to valvular mischief. The phenomena are much more suggestive of partial arrest of the retinal or choroidal blood supply by the paralysing effect of cold in a person whose terminal circulation, as in the subject of the first case, was very feeble. The question is whether cold applied to the surface can cause contraction

of the deeply lying vessels? I believe that few would have accepted such an explanation—I certainly should not—even tentatively, until the publication by Hertel* of the results of his researches on the effect of heat and cold applied to the surface of the eyelids. According to Hertel the temperature not only of the conjunctiva, but of the tissues of the orbit behind the eyeball—and presumably, therefore, of the structures of the eyeball itself—is lowered several degrees by cold and raised several degrees by heat applied to the surface. This effect he attributes mainly to conduction through the tissues, not to deprivation of blood by contraction of arteries, though the range of alteration of temperature appears to be increased if the circulation be stopped.

Assuming the correctness of Hertel's conclusions, we can interpret the cases above given by supposing that the cooling by conduction caused marked contraction of unusually susceptible retinal and choroidal arteries, and that the anæmia produced was sufficient, either alone or in combination with the lowered temperature, to depress almost to extinction the function of the retina.

It seems very desirable that Hertel's experiments should be repeated; the questions involved are of great importance.

* Hertel: "The Influence of Cold and Warm Compresses on the Temperature of the Eye," Graefe's Arch., xlix; abstract in Ophthalmic Review, vol. xix (1900), p. 18.

II. Berry's "Hyperplastic Subconjunctivitis" and Allied Conditions.

In 1892, Dr. G. A. Berry described at the Ophthalmological Society (Transactions, vol. xiii, 219) a peculiar condition of hard swelling of the parts beneath the conjunctival fold of the lower lid, under the title of "hyperplastic subconjunctivitis," and about the same time he described and figured the disease in the 2nd edition of his text-book, p. 113. He states that the condition is accompanied by little or no conjunctivitis or irritation, and that it disappears after some months without treatment, but adds that there may be chemosis, and swelling of the pre-auricular and even of the more distant glands.

The first of the cases given below shows that the condition described by Mr. Berry may sometimes be of serious importance as an early sign of Hodgkin's disease, and suggests that the glandular enlargements mentioned by Berry as having sometimes occurred in his cases may have had more than a passing importance.

Case 1.—Miss N., æt. 56 (P. 23.105) was first seen in July, 1891, with a peculiar semi-solid thickening of the entire retro-tarsal part of the conjunctiva of each lower lid; the thickened part was whitish and slightly translucent, and in the affected part of the L. lid, which was rather worse than the R., a few minute punctate hæmorrhages could be seen; there was only insignificant congestion. The upper lids were quite natural. She said that the cheeks had also lately been slightly swollen and stiff, but that it was "not erysipelas." V. 6/12. Slight myopia. Unfortunately I did not examine for enlarged glands.

The affection of the lower lids had begun several months before, when she was at Bournemouth on account of a tendency to bronchitis. She said the amount of irritation of the eyelids varied from time to time, but had never been worse than at present.

I neither saw nor heard any more of Miss N. till March, 1892, when Dr. Bramley Taylor, of Denmark Hill, asked me to see her with him at her house. She had been ill ever since the end of the previous summer, when Dr. Taylor found her urine to be very albuminous and containing some blood, but at no time could he find casts; during the winter she had some bronchitis and had scarcely been out of the house. There had been no œdema or swelling anywhere except in the lids and face. She had lost much flesh and become very pale. I understood that neither Dr. Pavy, who had seen her, nor Dr. Taylor had been able to detect enlargement of any glands except those below the jaw (about to be mentioned), nor any enlargement of spleen. The blood had not been examined, but I believe an examination was made within the next few days. At the date of our consultation the condition was as follows:—The swelling of the conjunctiva, though of exactly the same character as in July, 1891, had much increased and now affected both lids of both eyes, but was still limited to the retro-tarsal part of the conjunctiva, not passing back into the orbits at all and only invading the overlying skin to a slight degree; there were now no ecchymoses. On L. side the swelling was so great that the lids were almost closed and could scarcely be opened even by traction with the fingers; the lids however were very easily everted, and then, owing to the roll of dense tissue, were difficult to replace; there was no proptosis and the ocular movements were quite free. Eyes watery but free from sticky discharge. Sight not affected. Fundi normal;—no hæmorrhages.

About the root of the nose and in a less degree in the cheeks there was brawny, mostly subcutaneous, œdema, and in the submaxillary region on both sides were a number of loose, bullety glands. These were of no great size, but there must have been more deeply seated thickening also, for there was an impediment at the articulation of the lower jaw that prevented the mouth from being opened more than half an inch; this had come on recently and was increasing. No enlarged glands could be found anywhere else, nor was there any œdema, except in the face; her neck, body, and limbs were extremely thin, contrasting strongly with the face. I did not see her again, but Dr. Taylor told me that the cervical glands became much enlarged and that

the patient died rather suddenly about a fortnight after the above date, having for the last three days of her life suffered much pain in the shoulders and arms.

In the following case the same part of the palpebral conjunctiva was affected and apparently in a very similar manner, but only for a short time; and, in the eye first affected, the conjunctival swelling accompanied an attack of subacute iritis.

Case 2.—Jane W. (G. B. 2.14) came to St. Thomas's Hospital on February 20, 1891, for iritis in the R., with deposit of white lymph at the lower part of a.c., and numerous adhesions; the vitreous and fundus were normal; keratitis punctata not mentioned; the eye had been affected for a fortnight and there had been no severe symptoms. The only peculiar condition was a "semi-solid milky infiltration of the posterior part of the conjunctiva of the lower lid, covered with a thin muco-puriform pellicle." She was rather pale, had a chronic cough, and menstruation was excessive; no history of syphilitic symptoms. No enlarged glands detected. Atropine, bandage, and iron with quinine were ordered, and within two or three days the retrotarsal œdema had quite disappeared though the lymph was still present in a.c. But now (February 24) an exactly similar state had developed in the L. lower lid, though atropine proved that there was no iritis in this eye; by 27th this lid also was well again, and an examination of both eyes again showed the absence of disease of the vitreous.

It seems probable that this case began with iritis and that, owing to the state of the patient's health or of her blood, the ocular inflammation caused temporary deep lymphatic congestion or obstruction which afterwards spread to the opposite side.

In the next two cases a very chronic semi-solid œdema occurred in the lower part of the ocular conjunctiva, leaving the eyelid unaffected. The condition was limited throughout to one eye. No cause could be found, but it seems almost certain that some undetected local obstruction in the lymphatics of the neighbourhood was present.

CASE 3.—Mrs. B., æt. 62 (24.226) was sent by the late Dr. Richard Gravely, of Newick, on March 22, 1892, with a very marked degree of semi-solid œdema of the lower part of the ocular conjunctiva of the R. eye; it had begun in the previous January without apparent cause; there had been no pain and only trifling irritation. The L. was quite natural. A month later there was no alteration, though she had used a lead-lotion compress to the eyelids with more or less regularity. Dr. Gravely could find nothing wrong with the teeth or antrum. The eyes were widely different in refraction, the R. H.m. 1 D. V. 6/9, the L. (used for reading) M. 5 D. V. 6/12; but both were healthy in all parts so far as ophthalmoscopic examination showed.

She said that on two occasions she had had "a red streak of lumps on the R. forehead about a finger's breadth," lasting perhaps a fortnight, but not itching nor weeping; also that once or twice she had had a moist eruption on the cheeks and forehead. She was subject to "rheumatic stiffness" of the knees, but without swelling. I did not see Mrs. B. again, but Dr. Frank Gravely writes in answer to my recent inquiry (Dec. 1901) that soon after I saw the patient in 1892, she had a sharp attack of inflammation in both eyes (caught in visiting at a cottage, the patient thinks), that when this subsided the œdema of the R. conjunctiva was found to have disappeared, and that the eyes have remained quite well ever since.

CASE 4.—Charles P. 61 (G. B. 2.37), a chair-maker, living at Battersea, came under my care at St. Thomas's Hospital, in June, 1892, with "semi-solid transparent œdema of the lower half of the ocular conjunctiva" of the R. eye extending quite up to the corresponding part of the edge of the cornea: I particularly noted that there was no infiltration of the retro-tarsal part. A week later slight quiet œdema of the corresponding cheek and external aspect of the lower lid was noted; it may have been present when he first came. He had lost all his upper teeth, and there were no signs of disease of bone or antrum. The urine, examined more than once, contained neither albumen nor sugar. He had somewhat failed in strength the last two years, but had had no illness. When a child he had small-pox, and

some pits were still visible. No enlarged glands could be found. The nose was not examined.

He said the eye had been like this for 8 months before I saw him, and he remained under my care for 8 months (till February, 1893), making, say, a year and a-half in all, and even then the condition, though much less marked, was not cured. He said that it began without any severe inflammation, and certainly no conjunctivitis occurred whilst under our notice, though he complained at times of smarting. He said the swelling was rather less every morning and got worse as the day passed; and that it was always made worse by hot air and relieved by cold.

He used various lotions and kept the eye tied up as much as he could—at one period for as much as 4 days a week, and every night—and took iron and arsenic. After 7 months of such treatment as an out-patient the condition was (January 17, 1893) neither better nor worse. At the end of January, I took him into the ward and kept him in bed continuously, with the eye bandaged, for a week, with the result that the œdema entirely disappeared; but on February 14, when he had been up again for some days, it was beginning to return, chiefly on the nasal side, in spite of the bandage being applied every morning before he left his bed and worn all day till bedtime. He does not seem to have come again after this date.

III. On some Cases of Partial Albinism.

It is well known that albinos suffer almost always from nystagmus and defective acuteness of sight; that there are many degrees of albinism; that in some albinos gradual pigmentation of the hair and skin takes place, so that in after life the term, in so far as it is based on the complexion, may cease to be applicable; that a considerable amount of ametropia is a common accompaniment;* and that the condition often affects more than one in a family.

We also meet with cases of nystagmus with unexplained imperfection of sight, ametropia and blue eyes, *i.e.*, incomplete pigmentation of irides, occurring in more than one of a family. In one such instance that I recorded in vol. xi, p. 366, of these Reports, nystagmus occurred in no less than six males of the same stock; all had blue eyes, and the two of them whom I saw had a high degree of astigmatism, chiefly hypermetropic. It was stated that no cases had occurred in females, and none in males with brown eyes, and the one brown-eyed boy that I saw proved to be emmetropic with steady eyes. The fundus in one of the affected boys was "pale in the y. s. and o. d. region, but there was nothing unusual, and certainly nothing positively unnatural" in the appearances. These six affected boys belonged to three families of the same stock, and the inheritance in all was through the mother.

In 1882 Mr. Lloyd Owen published a remarkable example of nystagmus affecting many males of the same stock through no less than four generations, and here again transmission was always through the mother, though no females whatever were affected. In several of the children in this series the

* M., according to Fuchs; As. and other forms of Am., according to Landolt; H., according to Hutchinson in these Reports, vol. vii, p. 37. I have notes of refraction in 14 cases (including those published or referred to in the present paper)—there was considerable H. or H. As. in 9, almost Em. in 3, high M. in 2 (both children).

hair was fair, and the fundus oculi of light colour from subnormal pigmentation; but several of those affected in the previous generation, and therefore much older at the time of publication, had dark hair. The vision, refraction, and colour of the eyes is mentioned in only one of the whole series, a boy of 15 who had blue irides, light brown hair, and very light coloured choroids, and was hypermetropic, with very imperfect vision; but we may take it as probable that some if not all of the other affected individuals also had blue eyes, and it would seem that all of them were more or less amblyopic.

Mr. Lloyd Owen's paper* was entitled "Hereditary Nystagmus," but partial albinism seems to have been present in his mind, for he says that the fundus in one of his cases was "lighter than is normal, even in light-haired people short of albinism." My own case, above referred to, was recorded as illustrating one amongst several forms of congenital amblyopia, in which "a high degree of astigmatism was associated with nystagmus and amblyopia and with blue irides."

I now think that my cases and those of Mr. Lloyd Owen were really all instances of incomplete albinism, and that the additional cases given below belong to the same category. But even on this hypothesis the cases are puzzling. Why should all these subjects be males when we know that full albinism may affect either sex? Does full albinism when hereditary, as in the present group, always descend through the mother, even though she be herself unaffected?

Why are all the subjects ametropic, and many of them astigmatic? Pressure by the spasmodically half-closed lids may account for refractive changes in cases where (as in full albinism) there is constant intolerance of light; but there is no such cause in cases of very incomplete albinism.

In what relation does the amblyopia stand to the deficiency of pigment in the eye? Many persons with blonde complexion, blue irides and correspondingly light fundus have perfect sight; even almost complete albinos occasion-

* Lloyd Owen: Ophthalmic Review, i, 239, 1882.

ally have nearly full vision and steady eyes.* But here we have a group of persons who, several years after birth, show a very considerable congenital nystagmus and amblyopia combined with only relative deficiency of colouring matter.

The answer may be that full albinism, even for a short period after birth, prevents the after development of the visual function, even though more or less pigment develops soon afterwards in the retina, and that the cases mentioned above were quite albinotic for the first few months of life: the history however does not bear out this supposition in all of them. Or further, as the pigmentation of normally sighted eyes by no means always corresponds with that of the skin and hair, so it is possible that further search may show variations in the pigmentation of different parts of the same eye—*e.g.*, a translucent iris which impairs the contrast of the retinal images co-existing with a well-pigmented fundus—or even of different parts of the same fundus. Are cases known in which without disease the pigment is wanting at the periphery, though good at the central part of the fundus? and might such a condition explain the occasional occurrence of what seems to be stationary congenital night-blindness without ophthalmoscopic changes? In this connection we may ask whether the light-sense is fully developed in albinos of various degrees? No doubt they are intolerant of strong light, but are their retinæ normally sensitive to very feeble illumination? I do not know whether variations of the light-sense in normal eyes have been systematically connected with differences of pigmentation.

P.S.—Since the above was written, my friend Mr. Herbert Parker, Surgeon to the Central London Ophthalmic Hospital, who has paid more attention than any one else I know to the estimation of light perception, has examined two albinos kindly sent to me by Mr. Lang and Mr. Treacher Collins.

* As in case XVIII, vol. xi, p. 367, of these Reports. Also in the case illustrated in Jaeger's Atlas the patient, a girl of 16, was emmetropic, and read 1 J. from 4″ to 14″.

In Mr. Lang's patient, a completely albinotic boy of 13, the light sense measured by Mr. Parker with his modified Forster's Photometer, was practically normal. There was very high H. As.; V. 6/36 when corrected; quick nystagmus with wide movements.

In Mr. Collins's patient, a male æt. 19, formerly, but not now, fully albinotic (light yellowish hair, no red reflex through the blue irides), Mr. Parker found the light sense reduced to 1/9 in the R. eye and 1/5 in the L., and the light difference perception tested by means of a modified form of Charpentier's Light-difference Photometer, lowered from about 1/10 (the normal) to 8/10 in the R. eye and 4/10 in the L.

This led to enquiry as to night-blindness, and the patient said that he had never been able to see well at night, and was liable to tumble over things, and to pass people whom he would have recognised by daylight.

On March 24, I measured his fields of vision in daylight, using a 5 mm. test object, and Mr. Eason, Mr. Collins's assistant, afterwards measured the right field in the very subdued light obtained by drawing down the almost black blinds—a light just compatible with a full field in Mr. Eason and myself. We found a nearly concentric contraction of both fields, the loss varying from 10° to 20°, and occasionally 30°. The field taken in dull light was decidedly smaller in the nasal half than that taken in full light, the loss being often 25° to 30°. All the observations were carefully made and repeated two or three times for each meridian.

The fundi showed no conspicuous changes, but Mr Collins thought the epithelial surface granular and irregular in texture at the periphery; o. ds. and vessels normal.

V. now 6/18 with each eye with his H. 4 D. corrected; some As., but cylinders do not help. Colour-sense normal. Quick lateral nystagmus.

CASE 1.—*Nystagmus and Imperfect Sight with Blue Irides and H. As.*

Master McC. (9.220), æt. 13 when I first saw him in 1884, had horizontal nystagmus of small range, which was said to have been present from birth; he had always been "near-sighted." His mother had good sight; her father, however, was "very short-sighted," but I do not know what his refractive condition was. An elder brother also was "short-sighted." There was "short-sight" on the father's side too. The patient had slight convulsions between the age of 8 months and 2 years, but this does not seem to bear on the state of his eyes. Irides blue-gray. Hair was never very fair, and is now a light "mousy" brown. Colour-vision normal (Ole Bull's Colour Confusion Table). V. 6/18 and 1 J. at 7″.

He had H. As., and after the use of atropine the condition was:—

R. + 2 D. c. axis nearly vertical
+ 1·5 D. s. } 6/18.

L. + 2 D. c. axis nearly vertical
+ 1 D. s. } 6/12.

Fundi normal, not noted as specially pale, but some superficial (*i.e.*, epithelial) irregularity thought to be visible on nasal side of each O. D. Spectacles ordered for reading. In 1888, æt. 17, I found he had for some time discarded his glasses, because he could do as well without them.

Under atropine now—

R. chose + 4 D. c. axis, as before. 6/12 partly.
L. + 1 D. c. axis, as before. 6/12 partly.

And the spectacles were altered accordingly.

A year later (1889), "the glasses are not of much use." In 1890, under atropine, I found 0·5 D. of M. with the same As, as last time, and V. as before. In 1892 the My. had not increased beyond 0·75 D., and V. and As. were unaltered.

He had proved to have good mathematical ability, and took his degree at Cambridge in the Mechanics Tripos, afterwards passed into the army, and has since been on active service as a signalling officer in one of the Indian frontier campaigns.

CASE 2.—*Albinism of the Eyes with Dark Hair and Well-pigmented Skin. Myopia. Nystagmus. Amblyopia.*

Master C. (26.92), was brought for imperfect sight in October, 1892, when he was 11 years old, and again in July, 1895, when he was 14. The conditions were exactly alike at both dates. He read 4 J. slowly when held very close, chose −9 D. for distance, V. with it being barely 6/60; had slow lateral nystagmus of both eyes, and disliked bright light, so that since he was about 7 he had worn smoked spectacles (−5 D). He was intelligent, and got on pretty well in spite of his imperfect vision. Colour vision quite good (Ole Bull's Confusion Table).

His irides were light gray, and though not actually transmitting the pink fundus reflex in daylight, were translucent; pupils acted well. The fundus in each eye was that of a typical albino, "every choroidal vessel stands out clearly as if there were no other structures, just as in the Plates of the albinotic fundus in Liebreich's and Jaeger's Atlases. In each eye a very large choroidal trunk, (?) artery or vein, passes from the edge of O. D. straight outwards to the y. s. region—indeed in the L. eye this vessel comes from within the border of o. d. as if it had passed up in the trunk of the nerve. The absence of pigment, *i.e.*, the visibility of the choroidal vessels, is perhaps rather *more* marked at the central region than at the periphery."

Notwithstanding this condition of the eyes the scalp hair was dark brown, the eyebrows and eyelashes dark and long, and the skin well pigmented, and his father said that the boy did not "burn" much from exposure to the sun.

The father said that the patient was never at all fair-haired, even as a young child. The eyes oscillated very much at birth; there was never any head nodding. His mother's eyesight was good. Her father (patient's maternal grandfather) had peculiar vision and oscillating eyes; the colour of his hair is not known; his parents were not cousins. No further history can be obtained.

CASE 3.—*Incomplete Albinism with Nystagmus and Imperfect Sight M. As.*

Master Geo. B. (26.152) was brought in November, 1892, at

the age of 4, because he held everything so close to his eyes and saw indifferently at a distance. He had lateral nystagmus, which was at its minimum when he rotated his head to the left and depressed it towards the left shoulder, *i.e.*, when he was looking up and to his right; he adopted this position when looking carefully at objects. His hair was very fair, though far from white; the irides blue or gray and not translucent; the fundi normal, but the choroids very pale coloured from want of pigment; the velvety red of the central region, due to the close meshes of the chorio-capillaris there, well marked. The shadow test, after the use of atropine, showed simple My. As. about 1·5 D. in the vertical meridian, and he was ordered −1·5 D. cylinders.

Two years later, when he was 6, I found his V. to be 6/60 with his glasses, and the same without them if he squeezed his lids together. The shadow test, after the use of atropine, now showed, or seemed to show, considerably more As. and some M., and with correspondingly altered glasses he improved during the next year and a-half, so that when he was between 7 and 8 years old V. was 6/24 and sometimes 6/18. He still invariably turned his head to the left, *i.e.*, looked towards his R., and thus of course looked obliquely through his glasses, this obliquity being increased by another habit he had acquired of pulling the right side of the spectacles forwards. The refraction again measured, under atropine, in February, 1897 (æt. 8½), showed My. As. 3·5 D. in L. and 4 D. in R., and I ordered −4 D. cylinders, though he saw no better with them than with the somewhat weaker ones he had been using. The R. eye, separately tested, now seemed defective (6/60 ?); with L., and with both together, V. was 6/24. Subsequently +4 D. cylinder was ordered, in addition, for reading, as he preferred it. In this way he got on fairly well, and when I last saw him, in May, 1901 (aet. 13), V. was 6/18 partly with −4 D. cylinders, and he was doing well at school. His hair was now a dull, flaxen colour ("tow colour"). He was well-grown, strong, and keen, though of course backward in books. Another oculist has examined him again since then, and finds the refraction not very different from my first result in 1892, and has accordingly reduced the cylinders, V. being still 6/24; he also finds that V. is equally good in R. and L.

This boy's eyes were noticed to "work" a few days after birth; there was no "head nodding," he had no fits, and his health as an infant was good. His hair was white at birth, and his skin was, and is, extremely fair, but he has become liable to freckles. His eyes (pupils) were never "pink." He had influenza badly when 3, and again when 7 years old, with resulting cardiac weakness, and all attempts at book learning were forbidden by his physicians till he was about 10, but the heart is reported now to have recovered.

He is the fourth child; was born at full time, and his mother was quite healthy when carrying him. No. 1, a boy, 8 years older than the patient, is said to have been born with dark hair, which turned fair, and to have blue eyes and fair skin; No. 2 (girl), also born with dark hair, has blue eyes and dark skin; No. 3 was premature, and died in infancy.

The amount of ametropia, and especially of the astigmatism, diagnosed in this boy's eyes varied a good deal at different examinations, but I think these results were due chiefly if not entirely to the patient's habit of rotating and tilting his head in such a way that he always looked upwards and to his right. The effect of the resulting obliquity of his line of sight in relation to the plane of his (concave) lenses would be to increase the power of the lenses required to turn the shadow (unless these could be held in a correspondingly oblique position), and to diminish in a similar manner the strength of spectacles placed in the usual position on the face. The exact amount of this alteration could not be calculated accurately in his case,* because his spectacles were sphero-cylinders; his line of sight did not correspond to either of the chief meridians of the lenses, and the exact degree of obliquity that he employed no doubt varied in different circumstances.

CASE 4.—*Incomplete Albinism. Oscillation of Eyes and Head. Subsequent Pigmentation of Hair, but no Improvement of Eyes. Hypermetropia.*

Master B. (26.232) was sent by Dr. Russell Dodd in January, 1893, when 11 years old. His hair was fair, but far from white, pupils slightly pink, irides light blue and translucent on ophthal-

* See Ward Holden on "The Cylindrical Equivalent of Tilted Lenses," &c. Tables III to VI, Knapp's Archives, xx, p. 2, 1891.

moscopic examination. At the equator and periphery of the fundus in each eye every choroidal vessel was seen with absolute distinctness, owing to complete absence of pigment, and apparently (but of course only apparently) of chorio-capillaris; over the central area, well towards, though not reaching quite up to, the equator, the fundus was of the normal velvety bright red, no choroidal trunks being visible. This full-red area was much larger, and the transition from it to the peripheral zone of visible trunks much more abrupt than is shown in Jaeger's Atlas, my note being that—"The difference between central and peripheral regions as regards apparent capillary supply of choroid is extreme."

The patient was backward in reading, and needed large print. I found he could read up to 8 J. by holding it very near, but nothing smaller, and V. was less than 6/60. Refraction considerably H. There was rather quick lateral nystagmus of moderate range, and when reading, his head also oscillated laterally; I thought this was not so quick as the oscillation of the eyes, but could not be certain.

After the use of atropine the shadow test showed in

R. H. 4·5 with 0·5 to 1 As.
L. H. 6 with ? 0·5 As.

and he was ordered +3·5 D. for reading.

In March, 1899, æt. 17, he was "getting on pretty well," was strong and well grown, but had a nervous, agitated manner. The nystagmus, oscillation of head, and condition of the eyes were in every particular exactly as before, neither the irides nor the fundi being any more pigmented, but his hair was now decidedly brown.

V. R. Hm. 3 d. with $\left\{\begin{array}{l}+3\text{ s.}\\+1\text{ c.}\end{array}\right\}$ 6/36, well.

L. H. 4 d. $\left\{\begin{array}{l}\text{with }+4\text{ D. s.}\\\text{with or without }+1\text{ c.}\end{array}\right\}$ 6/36, not so well.

In this case the nystagmus had not been noticed till the age of 6 months, when the boy had whooping cough. His hair was almost white as an infant, but gradually became coloured. He was the second of four children. No. 1 died of whooping cough; Nos. 3 and 4 have good eyes and nearly black hair.

IV. Case of Uniocular Spasm of Accommodation.

There seems to be no weak point in the evidence in the following unusual case.

Miss O., æt. 21 (48.134), came on November 21, 1898, complaining of defective sight in her R. eye. She had found it out about a week previously, when she had resumed the use of her typewriter after a long rest. She was quite aware of the defect when both eyes were open, and it annoyed her.

I found the visual acuity and refraction as follows:—

R. 6/60, chooses very definitely − 3 D. 6/5; unaided reads 1 J., best at 6″. Fundus normal; refraction estimated H. 1 D. at O. D. but Acc. constantly varying; the eye sometimes has little fits of fine tremor when under ophthalmoscopic examination. Shadow test shows H. L. 6/9 slowly, Hm. at first 1 D., on second trial 2 D., 6/5. Unaided reads 1 J. best at about 12″. Ophth. n. Refraction estimated H 2 at O. D. Pupils not noted.

For reading 1 J. comfortably and without sense of difference between the two eyes she requires

$$\text{R. } - 1{\cdot}5 \text{ D.; L. } + 1 \text{ D.}$$

After atropine for two days:—

$$\text{R. } 6/18: \left\{ \begin{matrix} +1 & \text{D. s.} \\ +0{\cdot}5 & \text{D. c.} \end{matrix} \right\} 6/5; \quad \text{L. } 6/18 \left\{ \begin{matrix} +1 & \text{D. s.} \\ +0{\cdot}5 & \text{D. c.} \end{matrix} \right\} 6/5.$$

Ordered full correction, for all near work; no glasses for distance.

A year later (November 13, 1899) Miss O. came again for pain in R. eye of a few days' duration; V. at first was R. 6/24, but after some waiting it improved to 6/9:

$$\text{and with } \left\{ \begin{matrix} -1 & \text{D s.} \\ +0{\cdot}5 & \text{c.} \end{matrix} \right\} 6/5 \text{ slowly.}$$

L. 6/5 easily at once; better with + 0·5 c.

Pupils equal and acting fairly.

R. palpebral fissure was rather narrower than L. as if from slight spasm, but no tremor was visible.

This young lady was highly skilled and very quick in shorthand and typewriting; she worked intensely at whatever she did but had not much staying power; her mother told me the patient had always been subject to twitching movements of the face, but none were noticed when she was with me.

IV. Case of Slight Sore on Finger causing Axillary Abscess. Then, one-sided Anterior Headache and Rapid Failure of Corresponding Eye, and soon after of other Eye, from Neuritis leading to Atrophy. ? Septic Inflammation in front of Chiasma.

Mrs. W., æt. 42 (52.135), was sent by Dr. Florence Orford, of Pontefract, in February, 1900, nearly blind from atrophy of the optic nerves. I saw her on 13th and again on 22nd.

The R. had no sight except in the upper-inner part of F. where she could see my hand. P. showed very little direct reflex action. O. d. pale, yellowish, very slightly hazy, vessels rather smaller than in L., a few slight dots about y. s., but no signs of previous œdema either of o. d. or retina.

With L. she saw 6/36 and sometimes 6/24, but found the letters slowly owing to the very small size of F., of which only a sector passing from the centre upwards and inwards remained, exactly symmetrical with the surviving remnant in R. P. always smaller than R. and acting fairly well to light. O. d. less pale than R., veins rather large, arteries normal. Some white lines along the veins on both discs.

No oculo-motor paralysis. Hearing good, but the sense of smell (iodoform) not at all prompt.

She was a pale rather sallow woman, had been married 12 years, had one child, æt. 11, and had had no other pregnancies. She and her husband had a small house and let lodgings. The history, obtained from her own account and from notes supplied by Dr. Florence and Dr. John Orford and Mr. Adolf Bronner, was as follows :—

She had been in poor health and had suppression of menstruation all the summer of 1899, though suffering from nothing that took her to her doctor, when, about the end of September, she had a small "festered sore" on the dorsum of R. index finger, which, however, did not prevent her from attending to her house work as usual. It soon healed but was followed by a swelling in the axilla, for which she saw Dr. Florence Orford, on October 26. This rather slowly matured into an abscess with

gradual rise of temperature, during part of which time she was ill enough to be in bed. Dr. John Orford opened the abscess (about one ounce of pus), and temperature gradually became normal. Several weeks passed between the commencement of the glandular swelling and its maturation.

Either shortly before or soon after the abscess was opened, she began to have headache, and within a few days of the operation she complained of severe pain on turning the L. eye out, and had to turn her head when she wanted to look to her L. The pain then extended to, or became localised in, the L. frontal and temporal region, and, whilst she was still in bed, the sight of L. eye failed quickly. The eye became absolutely blind for a few days and then recovered some sight. The patient said that the L. again failed and again recovered, but this is not confirmed by the medical notes. However this may have been, about 10 days after the first failure of L. the R. eye failed rapidly in a similar manner, and as the patient was then convalescent she was sent, on December 18, to Dr. Adolf Bronner, at Bradford. This was 10 to 12 weeks from the occurrence of the sore on the finger, about 5 or 6 weeks from the incision of the abscess, say 3 weeks after failure of the L. eye and exactly 6 days after failure of the R.

When admitted at the Bradford Eye Hospital, the conditions found by Dr. Bronner were:—

R. no p. l.; O. D. nearly normal.
L. 6/36; O. D. showing signs of subsiding papillitis.

She was put on mercurial inunction and iodide of potassium and kept in for a month, during which time both o. ds. became pale.

Headache seems to have ceased whilst in hospital and did not recur The patient says she never lost her smell and had no discharge from the nose. She believes she was deaf for a short time whilst in the hospital, but Dr. Bronner did not mention this in his note to me. The urine examined at the commencement of the axillary abscess was free from albumen and sugar. There were not at any time the slightest indications of constitutional syphilis; nor was the course of the sore on the finger like that usually taken by a chancre. No reason to suspect glanders. There were neither signs nor symptoms of orbital

inflammation, or affection of oculo-motor nerves; for the pain in turning the L. eye outwards and compensatory rotation of the head might be explained by localised inflammation of the sheath of the optic nerve without paralysis of the external rectus.

There seems no reason to doubt the dependence of the optic neuritis and blindness in this case upon the illness due to the axillary abscess; but whether the optic nerves were poisoned by a toxic condition of the blood, or affected at their junction with the chiasma by inflammation of the underlying periosteum or bone, cannot, I suppose, be settled. On the latter hypothesis septic embolism may be supposed to have occurred on a small scale. The surviving remnants of the visual fields—of the temporal hemianopic type—would be compatible with disease at the anterior central part of the chiasma or the adjoining parts of the optic nerves at their emergence. Nothing in the case suggests thrombosis of venous sinuses, nor was there any positive evidence of suppuration in the sphenoidal sinus.

P.S.—January, 1902.—I hear from Dr. Florence Orford that Mrs. W. is now in good health, and her sight considerably better than it was two years ago. The outer part of R. f. is wanting, but she can read ordinary print with each eye, with her + 1·5 D spectacles and can see to do her housework.

V. Case of severe Single Retrobulbar Optic Neuritis leading to Complete Atrophy. Commencing Sarcoma of Suprachoroidea near the Yellow Spot in the corresponding Eye.

Mrs. ——, 40 (45.180), was sent by Dr. Pigeon, of Hull, on February 22, 1898. Incipient tumour of the choroid had just been diagnosed in the R. eye by an ophthalmic friend in London, and a second opinion was sought.

It may be mentioned at once that ophthalmoscopic changes resembling the earliest stage of choroidal growth near the y. s., co-existed with symptoms and appearances pointing to retrobulbar optic neuritis or some other acute process in the nerve. The co-existence of such apparently unrelated conditions much increased the difficulty of deciding what course to recommend.

Mrs. —— gave the following history:—On Sunday, February 6 (16 days before I saw her), she had pain in the R. forehead, top of the orbit, and behind the eye, with watering of the eye and some swelling of the lids, especially the upper lid; the pain was present chiefly during movements of the eyeball. She was seen by Dr. Pigeon on 10th and 14th, and by Mr. A. L. Roe in consultation on 17th. She began to notice that the sight of this eye was failing between 10th and 14th; at first she could see the doctor's forehead when she could no longer see the lower part of his face, this and other tests all showing that the lower part of the F. failed first; by the evening of 17th the eye had become totally blind, and it had remained so ever since.

When I saw her on February 22 there was still some pain in movements of the R. eye; no displacement of eye, no swelling of lids, and no restriction of movements; T. n.; there was the barest p. l.; pupil dilated from atropine; media clear; o. d. perhaps slightly pale but not hazy as compared with L.; veins rather beaded on o. d., and arteries rather smaller than in L.; slight spontaneous pulsation both of arteries and veins on the o.d. A large circular patch of the choroid above the macular region was of a yellowish-gray colour, somewhat mottled but not showing any visible choroidal vessels, slightly raised (H. 3 D. at the

middle or most prominent part, against Em. at y. s.), the lower border well defined, the upper border passing more gradually into healthy choroid. The area of this patch was from four to five times that of the o. d. It was crossed near its lower part by the upper temporal vein, and higher up by the corresponding artery; it was quite above the upper macula artery. The overlying retina was silvery, reflecting too much light, and showed slight undulations of surface but no proof of detachment. No hæmorrhages anywhere. Other parts of fundus n. The other (L.) eye perfect in every way and Em.

The patient, a rather florid lady, had a baby 4 months old, which had been suckled for the first 6 weeks only; she had menstruated once since the confinement. She had had influenza slightly some weeks after the confinement. She had been married 10 years; six pregnancies, the first two ending in miscarriage, the last four living and healthy; there was nothing pointing to syphilis. The family history pointed to tubercle:—a maternal aunt died of "consumption," æt. 16; Dr. Pigeon had lately operated on the daughter of the patient's only sister for tubercular glands; and the patient herself when a girl had been thought to have one lung weak, and was much taken care of for several winters. The patient's father died of drink; he had only two children, the patient and her elder sister.

With the above history and the very unusual relation between the onset of the eye-symptoms and the ophthalmoscopic changes, I thought it right to wait and treat for a time by mercury; but I sent her to Mr. Marcus Gunn before deciding. He also advised waiting for a time and trying the effect of treatment, including cod-liver oil. She was accordingly put on mercury, and I believe took cod-liver oil regularly. Dr. Pigeon wrote that on March 16 (4 to 5 weeks after the sight failed) the patient had noticed slight return of vision in the lower part of the F., and that this extended over the upper part next day. On 18th he found she could see movements of the hand, and on the same date he observed slight tenderness of gums. Dr. Roe examined the fundus and found the patch certainly no larger.

On *April* 1 I saw her again, mercury having been continued with little or no intermission, but so as to avoid salivation. There was then no central vision, but she could count fingers

held about 30° below the centre of F.; and could see the hand at the periphery, except over a considerable area in the upper-outer part, which was blind. The blind part just below the centre, scarcely agreed with the situation of the choroidal patch; and the loss of the upper-outer part of F. had not any, even approximate, counterpart at the fundus; p. acted to light; t. n. The choroidal patch was no thicker, indeed I thought it rather less H.; it was less uniform in appearance, more mottled, and the retina now showed little or no watered-silk reflection; the o. d. had become uniformly pale all over and was clear.

May 20.—R. cannot now see fingers anywhere, but the amount of absolute loss of F. does not seem larger; choroidal patch certainly more mottled, and perhaps more pigmented, but H. now to me only 1 to 1·5 D where formerly it was 3 D. O. D. now very white and perfectly clear, and one of the retinal arteries considerably constricted.

July 28.—Now no p. l. in any part of F.; thinks all sight went about a month ago. No fresh symptoms or appearances, but I estimate the highest part of the patch at H. 3 again, as at the first examination.

On August 2 the eye was excised, the optic nerve being cut at least 12 mm. behind the globe. Sections were made by Mr. Devereux Marshall, and I believe they were in the plane of the vertical meridian. Microscopical examination showed the choroidal thickening to have the structure of a sarcoma. The growth had evidently begun in the lamina fusca, with which its outer aspect was closely incorporated, and by which it was adherent to the sclerotic; indeed the sclerotic was somewhat thinned over the deepest part of the growth, though no trace of infiltration of its fibres could be found. The choroid itself was natural (except for turgescence of its vessels) at the margins (thinner parts) of the growth, but over the central (thicker) parts it was much atrophied and more or less infiltrated by the tumour cells; the elastic lamina was, however, intact everywhere, and the retinal pigment epithelium, though thinned and its nuclei diminished in number over the centre of the tumour, could be followed without a break quite across. The tumour cells were oat-shaped and in cross-section had almost exactly the diameter of a red blood-corpuscle; in the outer (scleral) part

they stained deeply with hæmatoxylin, and were very closely packed; the inner layers were less stained and more loosely packed. There was more pigment in the growth, especially in its inner layers, than the ophthalmoscopic appearances had led me to expect; it lay partly within the cells, but was partly the normal pigment of the suprachoroidea scattered amongst them.

The retina generally showed atrophy of its nerve-fibre layer; the other layers appeared to be healthy, except on a patch measuring from one-third to one-half the diameter of the tumour, and corresponding to its centre, *i.e.*, thickest part; here the bacillary layer and the outer granules had disappeared, and the outer molecular layer was represented by an open meshwork of fine fibres (Müllerian) containing scattered round cells, some of which were pigmented; this change in the retina over the centre of the growth was found in all the sections that included the centre. The tumour measured almost exactly 1 mm. in thickness at its deepest part, and thinned away quite gradually on both sides into healthy choroid. Its border was nowhere nearer than about $2\frac{1}{2}$ disc breadths to the margin of the o. d.

The optic nerve was atrophied: no healthy nerve fibres could be made out; the connective tissue trabeculæ were much nucleated and thickened, the small blood-vessels enlarged, and the inner (neural) layer of the arachnoid sheath irregularly thickened by deposit of cells, with oval nuclei larger than and quite different in appearance from the cells of the tumour.

It seems on consideration impossible to connect the tumour with the destructive retrobulbar neuritis in this case, and we must assume that these two rather infrequent conditions occurred in the same eye independently of each other, and that the tumour would not have been discovered till much later, but for the loss of sight caused by the neuritis. The small patch of degenerated retina over the centre of the growth must presumably have caused a corresponding defect in the field; but this retinal change was doubtless a gradual matter, and even had it occurred rather rapidly, owing to a corresponding advance in the growth, it would not explain the very extensive loss of field that took

place within 3 or 4 days. That this primary loss of field corresponded roughly with the situation of the new growth can have been only a coincidence. Even if the acute inflammation in the optic nerve set up collateral hyperæmia of the tumour, and thus led indirectly to some degree of œdema of the retina lying upon it, such as the early ophthalmoscopic appearances indicated, we cannot assume that the function of the swollen portion of the retina would be abolished unless the œdema led to microscopical degeneration co-extensive with the early loss of field; and such was not the case, for, as already stated, by far the larger part of the retina lying on the tumour was (with the exception of the atrophied nerve-fibre layer) microscopically sound. It is perhaps not impossible that a rapidly forming secondary growth in the bone or periosteum at the optic canal might have set up the optic neuritis, but gradual atrophy from the pressure would have been the more likely result of such a complication; and, moreover, there was not the slightest ground for supposing that secondary growth had occurred either in the orbit or anywhere else.

P.S.—January, 1902.—Dr. Pigeon informs me that the patient is now (three years and a half after removal of the eye) perfectly well, and the orbit quite healthy.

CASES OF MESOBLASTIC TUMOURS OF THE ORBIT.

By A. Quarry Silcock and C. Devereux Marshall.

Case 1.—William Arnold, æt. 28 (4198), a stonemason was admitted to the R.L.O.H. on January 11, 1894, with the following history:—

History.—About 3 years ago the patient noticed a swelling about the size of a pea at the outer part of his orbit. He was sent in for immediate operation.

A tumour was felt about the size of a small chestnut in the upper and outer quadrant of the left orbit, causing a considerable swelling beneath the skin. It was freely movable and tense. Its anterior surface was more rounded than its posterior.

A horizontal incision was made over the tumour, and by dissecting down its surface was exposed; it had a fairly well-defined capsule, but it was attached behind by a pedicle; this was cut and the wound closed.

Path. Report.—Encapsuled growth of firm consistency, 20 × 17 mm.

Microscopic Examination.—The growth is composed of irregularly-arranged fibrous tissue. At one part there is a series of sections of gland acini, some of which are dilated; others are simply lined with columnar epithelium, and resemble normal lacrimal gland. The growth is a fibroadenoma.

Case 2.—Samuel Herbert, æt. 32 (70, O.P.), was admitted on September 16, 1895, with a history that the left eye commenced to fail 3 or 4 months previously, and more recently the right eye has become defective. There is no history of injury or of syphilis.

Present State.—The left eye is pushed down and out: the media are clear, there is well-marked optic neuritis, the vision being 4/60 J. 18: movements upwards defective. Right eye, slight optic neuritis, V = 6/12 J i. Ordered, Pot. Iod., gr. x, and Ung. Hydrarg.

He was readmitted on December 12, 1895, for although the

treatment had been continued, yet there was no improvement in the condition.

On readmission the left eye was found to be much proptosed and displaced downwards and outwards, and the upward movement was interfered with.

There was a distinct swelling beneath the outer portion of the root of the orbit, which felt tense and elastic. The optic neuritis was well marked in this eye, and the disc in the right eye was very similar to what has previously been described. The left V. = 6/24 J. 8.

On December 12, 1895, the growth was cut down upon. It consisted of soft granular material, some of which was scooped out. There was considerable hæmorrhage, which was controlled with plugs of cotton wool soaked in turpentine.

He was not again seen until 1898, when he was readmitted on May 5. Two weeks previously the eye became suddenly painful and watery without any injury or other circumstance to account for its doing so.

Present State.—There is very marked proptosis and injection of the left eyeball, which is pushed down and out, the movements being greatly limited. A mass can be felt in the orbit. There is a large ulcer on the cornea; the iris is discoloured and the pupil inactive. V. = P.L. only.

On the following day the contents of the orbit were removed. This healed well and patient was discharged on May 25.

He has been seen at intervals since, the last time being February 1, 1901, when there was no sign of recurrence. The vision of the R. eye was 6/6 partly. The field was full, but the disc retained the same blurred appearance suggestive of neuritis which was first noticed in 1895.

Microscopic Appearance of Growth.—The growth is composed almost entirely of cells. Some parts of it are solid, the cells being packed together with little or no reticulum. At other places there are an enormous number of spaces, some of which are empty, but others contain hyaline material. Scattered through the growth are numerous vascular spaces, which contain blood, but there are no well-formed vessel walls. The cells are for the most part large, and contain single large nuclei, with but little protoplasm.

Case 3.—Mary Carr, æt. 53 (40., O.P., 4652), was admitted on July 3, 1895, with the following history :—

On February 25, 1886, patient was admitted under Mr. Streatfield suffering from "tumour of the orbit," which had existed for 12 months. "The right globe and contents of the orbit were cleared out; a soft lobulated growth removed with globe." Nothing of the nature of a solid growth was discovered by the pathologist.

She complains now of having suffered severe pains in R. side of forehead and vertex for more than a year, but has noticed a swelling in the orbit for only 6 months. This has been slowly getting larger and the pain more severe.

Present State.—There is a large rounded swelling about the size of a walnut occupying the right orbit. It is tense and has distinct pulsation, but no bruit can be heard over it. The mass reaches the outer wall of the orbit, but this portion is not prominent. The skin over the tumour is freely movable, and covered with dilated veins.

The following day an incision was made over the growth and the skin reflected; an attempt was then made to shell out the prominent part of the growth, but this was found to be impossible, as it extended backwards probably into the cranium. There was much bleeding, which was arrested by packing with gauze soaked in turpentine. A portion of the growth was removed for microscopic examination.

The temperature quickly rose, and patient became very ill. There was no optic neuritis in the left eye. A mitral murmur developed and she became comatose, and died on July 18.

An autopsy was made (42, O. P.).

The growth is composed of cells having rather large round nuclei. Mixed up with it is a considerable amount of pigment, the greater part of which is altered blood. Numerous areæ of hyaline degeneration are present, and the tumour is extremely vascular. It is a myxo-sarcoma.

Case 4.—Benjamin Armitage, æt. 41 (78, O. P., 4879), was admitted on January 23, 1896, with the following history :—

In October, 1895, he was first seen as an O. P. suffering from proptosis of the right eye with diplopia; this had been noticed about a month.

The only history of injury was about 5 years previously, when he was struck beneath one or other eye by a splinter of wood which penetrated the skin. There is no history of acquired syphilis, and no reason to suspect congenital syphilis.

Present State.—There is considerable proptosis of the R. eye with upward deviation of the globe; the downward movement of the eyeball is much interfered with.

Within the lower margin of the orbit a firm rounded swelling can be felt. Some dilated lymphatics are seen on the lower lid, as well as tortuous vessels on the sclera. The inner margin of the disc is slightly blurred, but the vision in each eye is 6/6 J. i.

He was first treated with mercury inunction and iodide of potassium internally, but without effect.

On February 7 a portion of the growth was excised, and it appeared to be connected with Tenon's capsule.

The mercury and iodide were continued, and patient was discharged on April 16. He was again admitted as the growth was evidently increasing in spite of treatment.

There was then found to be slight optic neuritis, and the vision with correction was only 6/18 J. 6 with the right eye, though it was normal in the left.

On April 17 the whole of the contents of the orbit were removed, which included a large growth which reached to the apex. The bone was scraped, and the apex, where apparently some growth remained, was burnt with the cautery. The patient did well.

He was not seen again, but information was received to the effect that he died on January 5, 1898, after a long and painful illness, during which the tumour spread to the other eye and to the spinal cord, causing blindness, paralysis, and great suffering.

Microscopical Appearance of Growth.—The growth consists of numerous small round cells and fibrous tissue, together with muscular fibres which are surrounded by the growth.

There are some bands of fibrous tissue which intersect the growth and partially surround it, as well as numerous spaces which contain blood and probably represent badly formed vessels.

The growth is a small round cell sarcoma.

Case 5.—William Graham, æt. 48 (4967), was first seen in April, 1894, with a "lipoma-like swelling" beneath the left upper lid, which had been noticed about a month. When 15 years of age, he had an iron-headed arrow shot into the left eyebrow, but this was removed entire.

On May 29, 1894, the growth was found to be adherent to the lacrimal gland, and the greater part of it was removed.

In February, 1895, the growth had recurred, and it was again removed, and found to extend deeply into the orbit.

On July 23, 1896, he was readmitted as the growth had increased much in size during the last few weeks.

Present State.—There are no enlarged glands to be felt. The growth is much larger than it was before, and is a semi-solid glandular-like mass which overlaps the cornea above, leaving only the lower portion uncovered. The globe is proptosed and displaced downwards, and its movements are almost completely abolished. The growth is adherent to the globe and the lower portion of the cornea is abraded.

On July 24, the whole contents of the orbit were extirpated. A large mass of growth was found to be filling the roof of the orbit, and extending backwards to the apex to which it was firmly adherent. Elsewhere it was removed clean with the periosteum.

Patient has remained in good health ever since, and when last seen, on November 28, 1900, there was no sign of recurrence, and he was in good health.

Microscopical Examination.—The growth consists to a very large extent of fibrous tissue; there are also small round and spindle-shaped cells. Numerous muscle fibres are seen in the section which are separated by the fibrocellular tissue of the growth. The orbital fat is largely infiltrated, and the blood vessels are large and well formed.

The growth is a fibro-sarcoma.

Case 6.—George Draper, æt. 60 (5016), was first admitted on February 28, 1888, with the history that 35 years ago a growth commenced in the left eye which was removed at Guy's Hospital, where he was told it was "fatty." The present lump has been noticed for 1½ years, with a rapid increase during

the last 2 or 3 months. An incision was made and the mass removed.

He was again seen on November 21, 1893, with the history that since the last operation things remained quiet for 2 years and then recommenced growing. Again it has been removed.

On September 21, 1896, he was admitted with a large swelling in the region of the left inner canthus. It was lobulated, and separated the lower lid from the globe. In places the mass was hard and adherent to the bone, but at other places it was soft and cystic. The globe was displaced upwards; but the eye retained good movement.

An incision was made over the tumour and a portion removed. The growth was extensive and invaded the spheno-maxillary fossa and the superior maxillary bone. It was removed as far as possible; but the eye was not touched.

Patient was not again seen nor heard of.

Microscopic Examination.—The growth consists of small round and spindle-shaped cells, containing a stroma which can be traced between each individual cell.

There are numerous spaces which are evidently blood vessels, but they have no well-formed vessel wall.

The growth is a mixed, round, and spindle-cell sarcoma.

Case 7.—Charles Love (5614), aged 9, was admitted on December 12, 1898, with the following history. Six weeks previously he had a blow in the right eye with a football. The next day a swelling was noticed which has increased in size since.

Present State.—Between the globe and the inner extremity of the R. lower lid is an irregular round and painless swelling extending from the margin of the orbit backwards. It is about the size of an almond. On everting the lid, the conjunctiva has a dark appearance in the cul-de-sac.

R. V. = 6/24 partly Cyl. − 2·0 70° 6/18.
L. V. = 6/24 partly Cyl. + 2·0 90° 6/12.

On December 13, 1898, the growth was removed, and the wound healed. The patient was last seen on February 1, 1901, when there was no sign whatever of recurrence R. and L. V. = 6/12.

Microscopic Examination.—The growth consists of numerous small round cells which are crowded together and contain but little stroma. No well formed blood vessels are visible, and there are but few strands of fibrous tissue running through the growth. It has the appearance of a rapidly-growing round cell sarcoma.

Case 8.—Alice Bayley, æt. 28, was admitted on July 12, 1897, with the following history:—

The left eye had become prominent for 16 months past. There was no pain, no history of injury, and no nasal trouble.

Present State.—The left eyeball is displaced forwards and somewhat downwards. The movements of the eyeball are free in all directions. There is a hard swelling at the inner and upper part of the orbit. L.v. = 6/6.

On July 13, the mass was cut down upon, and proved to be a new growth, a portion of which was removed, when microscopic examination showed it to be an endothelioma.

She was again admitted on October 3, 1898. The swelling was found to be much the same, and there was considerable frontal headache, and the L.v. = 6/18 partly.

There was marked proptosis; the movements of the eyeball were free.

At the inner extremity of the roof of the orbit was a hard irregular swelling, which protruded slightly, and extended backwards into the orbit. No glandular enlargement.

No operation was performed.

She was again admitted on January 16, 1899. At this time there was marked proptosis of the left eye, and slight displacement down and out. Convergence was slightly interfered with. Extending inwards from about the middle of the roof of the orbit is an irregular hard mass, which yields on pressure and causes pain; it extends backwards into the orbit. The left optic disc is pale and well-defined. L.v. = 6/36.

On January 17, an exploratory incision was made, and a probe could be passed backwards through the growth.

On January 20, the contents of the orbit were removed, and the patient did well.

On June 1, she was again admitted, as there was some

evidence of recurrence in the socket. This was readily removed.

She was heard of in April, 1899, at which time the doctor reported that the growth appeared to be recurring.

She has also been heard of in December, 1901, and the report states that but for a little discharge from the socket pit, is well and in fairly good health.

Microscopic Examination.—The growth consists of cells which are more or less round and spindle shaped, together with numerous clumps of what appear to be degenerated and compressed cells, somewhat resembling the cell nests in an epithelioma.

At places some pigment is seen, which forms part of the growth.

? Endothelioma.

CASE 9.—Mr. S., æt. 35, was first seen suffering from a proptosis with some swelling and a hard mass to be felt at the outer and lower part of the right orbit.

An exploratory incision was made, and a soft solid mass was entered, which was very vascular. A portion of this was removed, and after hardening, was submitted to microscopic examination, when it was shown to be an endothelioma.

On February 28, 1900, the eye, together with the whole contents of the orbit, were removed, leaving only the lids.

A large mass was then found at the outer and lower part of the orbit, not involving the lacrimal gland, but extending far back into the apex. Every piece of the soft tissue of the orbit, together with the periosteum, was removed.

The patient made an uninterrupted recovery, and now, in February, 1902, he is in perfect health, and there is no sign whatever of recurrence. The further portion of the growth was examined by Mr. G. H. Plimmer and Dr. Sidney Martin, who agreed with the diagnosis.

The cases here recorded of primary tumours of the orbit have been brought together partly with a view of determining more exactly the prognosis in this important class of case, and partly because several of them present features of interest.

In vol. xiii of the Ophthalmic Hospital Reports, Stirling recorded 29 cases of sarcoma of the orbit, and of these the prognosis was extremely bad, and left only a percentage of about 17 who had passed the three-year limit, although the cases whose history had been followed up showed that recurrence and death may take place at a much longer interval.

Sex.—Of the 9 cases here recorded, 7 were men and 2 women. This is a much higher percentage of men than Stirling found, for out of 29 cases, 14 were males and 15 females.

Age.—Of these cases the oldest was Case 6, a man æt. 60, while the youngest was Case 7, where the patient, a boy, was 9 years old. The average age of the patients was 38 1/9 years, while in Stirling's cases it was 28 2/12 years.

Side.—The growth occurred in the left orbit five times and in the right four times.

The known duration of the symptoms previous to operation ranged from six weeks in Case 7, to 10 years in Case 3, while in one case, No. 6, a tumour of the orbit had been removed 45 years before the last operation was undertaken, the result of which is unknown, the patient not having been seen or heard of since leaving the hospital.

Result.—Of the nine cases, five are known to be alive, two are dead, and two are unknown.

Recurrence.—Case 1 unknown.

Case 2. No recurrence after removal of contents of orbit in 1898.

Case 3. Patient died 15 days after operation. The growth was not removed, as it was found to extend into the cranium.

Case 4. Patient died 19 months after removal of contents of orbit of general recurrence.

Case 5. Recurred a year after partial removal, and again a year later after further removal: no recurrence since.

Case 6 was seen first in 1888. The contents of the orbit were partially removed in 1852. The recurrent mass was

excised in 1888. It reappeared in 1891, and in 1893 it was again removed.

In 1896 a large mass was present, which, on exploring, was found to involve the spheno-maxillary fissure and the superior maxilla. It was impossible to remove it, and the patient was never seen again.

Case 7 has not recurred since the growth was removed.

Case 8. The growth was partially removed in July, 1898, and the contents of the orbit were removed in January, 1899, since which time there has been no recurrence.

Case 9. Orbit cleared on February 28, 1900, since which no recurrence has taken place.

The operation of extirpation of the orbital contents, if done subperiostally, is simple, and we prefer to do it in the following manner:—

The edges of the lids, including the Meibomian glands, the hair follicles, and the whole of the conjunctival sac, are separated from the surrounding parts down to the bone. A periosteal elevator is then run round the edges of the orbit, and with this instrument the entire orbital contents are separated from the bone as far back as possible. The optic nerve, together with a small amount of surrounding tissue, is divided as near the optic foramen as possible, and the whole of the orbital contents, including the eye, are removed *en masse*.

As the parts cicatrise, the remains of the lids and the surrounding skin are drawn into the orbit, which becomes completely lined by skin. If the lid margins and conjunctival sac are left, these structures are not only useless, but they leave a mucous discharging surface or cavity at the back of the orbit which is a source of discomfort to the patient.

We strongly disapprove of the use of caustics, such as chloride of zinc paste, which are sometimes placed in the orbit after partial removal of its contents. We consider the practice to be both painful and dangerous, and certain it is that what cannot be with safety removed with the knife and chisel, possibly aided by the Pacquelin's cautery, had better

be left behind; clearly it is far better to know the full extent of the operation which is undertaken than to trust to a powerful chemical caustic which destroys an unknown amount of tissue.

The deformity after total extirpation of the orbital contents is, of course, great, and cannot be remedied; probably the best thing to do is simply to cover up the cavity with a celluloid shield attached to a spectacle frame.

That these tumours differ very much in character is at once obvious, and in the present state of our knowledge the origin of many is obscure.

Amongst the most interesting are those described as endotheliomata. Much has been written on this subject by Van Duyse, Coppez and others, tending to show that they have certain characteristics which lead one to suppose that they are derived from the endothelium lining the lymphatics of the orbit.

All that have been observed by us are when cut into often very soft and vascular. As a rule, as soon as the tumour has been incised there is considerable hæmorrhage, but with a sharp spoon some of the growth can be safely scooped out and prepared for histological examination.

No matter how free the hæmorrhage may be at the time there is no difficulty in stopping it with pressure.

They are unencapsuled, and the growth infiltrates the normal tissue of the orbit, and may be seen pushing its way through and separating such structures as muscle fibres, &c.

Endotheliomata show very marked local malignancy; that is to say, they have continued to grow so long as any of the tissue is left behind, but when once this has been thoroughly cleared out they have done well. So far as we have seen there has not been any marked tendency to generalisation, and when once the growth has been completely removed the patients have remained in good health, giving no sign that they were suffering from any visceral complication.

Very different are the result in cases of sarcoma, whether

pigmented or white, which occur both in the orbit and in the eyeball. For these, as was shown by one of us in the last part of the Ophthalmic Hospital Reports, the number of patients who died of general recurrence was large, and amounted to 58·62 of the cases which were traced.

Time, however, will prove this point, provided all the cases are strictly examined.

In conclusion we would urge the importance of recording such cases, for without a large number from which to draw conclusions, errors in diagnosis and prognosis cannot be eliminated.

ARCUS SENILIS.

By J. Herbert Parsons, Curator.

Very various opinions have been expressed from time to time as to the pathological changes in the cornea in arcus senilis, as will be seen from the following historical *résumé*:—

Duddell (1): "I take this opacity to proceed from the dryness of the parts; the pores being too close do not admit a sufficient quantity of fluid into the parts to maintain their transparency."

Plenck (2): "Videtur a vasis pellucidis in senio concrescentibus oriri."

Meckel (3): "It undoubtedly depends on the slowness with which the substance of the cornea is renewed, whence the fluids have more time to coagulate."

Walker (4): "It is composed of a firmer and more opaque substance than that of which the cornea is originally formed, arising from an impaired action of the secernent vessels which cease to pour out healthy corneal tissue."

Hays (5): "A deposit of lymph formed, perhaps, by a slow, chronic inflammation."

Seiler (6): "It arises from the approximation and closer attachment of the individual laminæ of the cornea, owing to the removal of the interstitial moisture."

Velpeau (7): "It cannot properly be attributed to disease of the cornea, the structure of that membrane not being altered nor its thickness increased."

Jeaffreson (8): "It is probably due to degeneration of the cornea itself, and not to any inflammatory deposit."

Lawrence (9): "No essential difference has been found in the part; there is no new growth nor any deficiency of its usual density. I can only compare it to the changes which take place in the internal coat of the arteries in old age."

Middlemore (10): "If it be not a mere alteration effected

by age, I am quite unprepared to say what it really is—no circumstance with which I am acquainted, except age, seems capable of producing it. The changes wrought in the arteries by age present the only analogy which now occurs to my mind."

Schön (11) "often examined the cornea affected with arcus, and found the affected portion changed into a homogeneous—sometimes fat-like (speckartige) mass, often of considerable firmness. The laminated structure has entirely disappeared—the laminæ being consolidated into one mass; this was more particularly the case with the external than the internal laminæ."

Artha (12) states that the peripheral parts of the cornea are converted into a tissue analogous to that of the sclerotic, in consequence of an atrophy of its fibres incidental to old age, and likens the change to that seen under the microscope in a corneal nebula.

Canton (13) first accurately described the microscopic appearances. He removed the fresh cornea, cut it into four quadrants, and pinned each portion to a wax tablet, and allowed them to become dry in a current of air. After drying, a very thin shaving was removed from the edge of the preparation, placed upon a slide in dilute acetic acid, and covered. Canton's careful description (well illustrated in his book) (14) is as follows:—"With a power of 200 diameters, we shall observe myriads of fine oil-globules in the situation of, and constituting the arcus. Many larger globules are present, and this magnitude has doubtless been attained by the coalescence of the smaller spherules. We notice also that the oil-drops are arranged in two ways:—1st, in the direction of such of the lamellæ as have disappeared, and which they replace—a fatty degeneration or conversion—and, 2nd, in the interstices, or between the lamellæ—a fatty deposition. The slight elevation which the cornea presents at the site of the arcus is due to this latter condition.

"At the commencement of these changes, the oil-drops will be found in the corneal cells, and often, too, are present

in the fine branches or processes prolonged from these cells; in the same manner as the contents of the cellular elements of other organs are, primarily, affected where fatty degeneration occurs, and where, in the further progress of the affection, we may notice also the intercellular deposit." . . . .

"I have never seen Bowman's membrane (anterior elastic lamina) nor that of Descemet (posterior elastic lamina) to be otherwise than unaltered." . . . .

"With respect to the rim of cornea lying just external to the true arcus, and which, as a general rule, is unaffected, it will be not unfrequently found, in instances where an arcus is very broad, or a dense circle exists, that this part has become implicated also to a greater or less degree by a continuity of fatty degeneration from the arcus itself. This occurs more commonly above and below, than at the sides of the cornea." . . . .

"I have in some cases found the fatty degeneration to extend completely into the line of junction of cornea and sclerotic; and have occasionally seen the interstices of the sclerotic fibres as they are becoming corneal laminæ, in many places, loaded with oil-drops."

Williams (15): "The arcus senilis owes its position on the upper segment of the cornea to the pressure of the upper eyelid, which, slight as it is, is sufficient to promote that change which results from weakened circulation."

His (16): "If thin sections through an arcus senilis are examined, the fat is principally found to consist of extremely fine globules, which are arranged in thickly set parallel thread-like rows. These parallel rows cross in various directions and so form a kind of thick network, which, when it is many layers thick, causes considerable opacity in the tissue. In some places larger groups of globules are collected, in the midst of which one or more stunted rudiments of a nucleus may occasionally be seen. These fat-drops have no capsule, and it is impossible to prove from their appearance only that they correspond to a degenerated corneal corpuscle. On the other hand there are undoubtedly

corneal cells with more or less fat within them, especially in the more posterior layers and in the parts where the opacity is less intense. Such cells are not actually enlarged, and the fat lies partly in the cell-body and partly in the fine processes and their ramifications."

Virchow (17) used the arcus senilis as a typical example of parenchymatous changes. He considered it a fatty degeneration of the corneal tissue, and due to deposition of fat in the cells themselves.

Castorani (18), in a paper to the Académie des Sciences, states:—(1) That the arcus senilis is the result of an immediate imbibition at the circumference of the cornea of the more or less abundant secretions of the conjunctiva; (2) that the more or less permanent contact of the eyelids with the cornea is an indispensable condition for this imbibition; (3) that the process of imbibition is in an inverted ratio to the resistance of the cornea and the density of the secreted fluids. The requisite conditions occur *par excellence* in the aged people who are subject to arcus, viz., increased conjunctival secretion, lessened mobility of the eyelids, and diminished resistance of the cornea.

Fuchs (19), in a paper on Pinguecula, says:—"Concretions of the same nature as those found in Pinguecula constitute the opacity of the cornea, which is called arcus senilis. Senescence of tissue leads therefore in the cornea to the same results as in the conjunctiva. . . . . The greenish-coloured round concretions which form it, lie for the most part immediately under Bowman's membrane. They consist of various sizes, from the smallest, scarcely visible up to 0·03 mm., mostly arranged in a single layer under Bowman's membrane. The larger concretions, by pressure on the posterior surface of Bowman's membrane, dig as it were niches in it, the largest thin the membrane very markedly and push it forwards. The concretions do not occur, however, only under Bowman's membrane; there are some which lie considerably deeper, between the corneal lamellæ. In some cases, indeed, I have only found large groups of

concretions here, whilst there were none present immediately under Bowman's membrane. On the other hand, there are concretions which are found within Bowman's membrane itself or even upon it. In the first case, when the concretions are very fine, the membrane appears as if dusted over, but it may also contain larger concretions. In the second case the concretions are imbedded between the cells of the corneal epithelium. There is never any relation to be perceived between the concretions and the cells of the corneal tissue; the hyaline substance is here, exactly like the yellow masses in Pinguecula, lying separated and free upon the surface of the connective-tissue bundles (here corneal lamellæ). The concretions in the cornea give the same reactions as the concretions in Pinguecula. I may here only further state that they undergo no change whatever with ether or chloroform, so that therefore they are certainly not fat as generally held."

In his text-book (20) Fuchs says:—"The arcus senilis is formed by the deposition of hyaline masses and minute particles of lime in the more superficial layers of the cornea, close to the limbus; its cause is assumed to be senile atrophy of the limbus, with involution of a portion of the vascular loops contained in it."

In a recent paper on a rare form of Peripheral Sclerosis and Atrophy of the Cornea (21), only found in conjunction with arcus senilis, Fuchs repeats his opinion that the arcus is due to hyaline degeneration, again citing the staining-reactions, and especially the fact that it stains black with Weigert or Pal's method, though hyaline material more usually only stains brown. He points out some resemblance to "Bandkeratitis," which Leber ascribes to drying of the cornea, and discusses the question whether the arcus is not due to an abnormal amount of moisture.

Leber (22) is of opinion that in arcus senilis there is a combination of hyaline degeneration with a deposition of calcareous material. In one case he obtained the very definite calcium reaction with oxalic acid.

Tweedy (23) writes:—"According to some investigations

made by the writer in conjunction with Mr. E. T. Collins, in the laboratory of Moorfields Eye Hospital, the change in the cornea consists in the presence of fine, highly refractive molecules, distributed along the course of the lymphatic spaces and channels of the superficial layers of the periphery of the cornea near the loop-endings of the capillaries of the conjunctival and episcleral blood-vessels. The greater portion of these molecules are not fatty, as is generally supposed; for, unlike fat, they are neither blackened by osmic acid nor dissolved by ether. They probably arise from mucoid degeneration of the protoplasm within the lymphatic channels and spaces of the cornea, and to some extent of the fibrillæ themselves. A few doubtful, blackened, fatty molecules may be seen here and there in sections stained by osmic acid. The fibrillæ are slightly wrinkled, and are more loosely held together than natural, and the spaces between the laminæ are wider. In support of the non-fatty nature of arcus senilis, it may be stated that wounds of the cornea, whether through the opacity, or to its inner side, or to its outer, and whether surgical or traumatic, heal in a natural way."

Takayasu (24), working in Greeff's laboratory, used Sudan III as a test for fat, and arrived definitely at the conclusion that arcus senilis is a fatty degeneration.

In my experiments I have used Sudan III and an allied stain, Scharlach R. The results confirm the description of Takayasu, and I have extended the observations by employing the stains as chemical indicators of the presence or absence of the arcus after the action of various reagents.

When stained with either of the dyes, the smaller globules are coloured reddish-yellow, the larger ones deep orange. With Scharlach R the stain has a brick-red tinge. The eyes were hardened in formol, the corneæ, including the iris and ciliary body, being then removed by a circular incision through the sclerotic 2 or 3 mm. behind the corneoscleral margin. The corneæ were then divided into quadrants, washed in running water to remove the formol, immersed in gum until penetrated, and cut with the freezing

microtome. After being freed from gum by warm water, sections were placed in saturated solutions of the stain in 70 per cent. alcohol. Stronger solutions of alcohol dissolve out the globules. In Sudan III the sections are well stained in from 10 to 15 minutes: longer treatment leads to slight diffuse staining of the corneal tissues, but this is washed out in subsequent treatment with 70 per cent. alcohol. It is possibly due to a fatty moiety in more stable combination in the normal tissues, for traces of fatty material can be extracted from almost every tissue of the body. Scharlach R stains more slowly, but does not tend to diffuse staining, even after prolonged (24 hours or more) treatment, and is, therefore, a more reliable test of differentiation. The sections after staining are washed rapidly in 70 per cent. alcohol, a more prolonged differentiation being required in sections over-stained by Sudan III. They are then washed in water, and counter-stained with Mayer's hæmalum or Ehrlich's hæmatoxylin. This stains the nuclei of the corneal corpuscles, &c., and to some extent delimits the corneal fibres. Hæmalum is preferable, as it is a pure nuclear stain: it may precede the treatment with the fat stain. The sections are then treated with tap-water until the hæmatoxylin is a satisfactory violet, and are mounted in glycerin.

In sections so treated, globules of varying size are seen to pervade Bowman's membrane and the corneal lamellæ in the affected area. Those in Bowman's membrane are usually the smallest, so small, indeed, that a general diffuse granular stain is all that is seen without the assistance of an oil-immersion objective. A few minute, isolated, well-defined globules may be seen in some cases. The stain is densest at the termination of Bowman's membrane, and this is the cause of the very definite peripheral edge of the arcus, as seen clinically. Bowman's membrane ends at an appreciable distance from the apparent corneo-scleral margin, and this distance is occupied by the clearer cornea which is characteristic of arcus senilis. That it is not in reality as clear as the centre will be evident from subsequent remarks.

Towards the centre of the cornea the stain in Bowman's membrane very gradually fades off, the distance varying with the development of the arcus in the particular cornea. It always, however, extends farther centrally than the stain in the substantia propria.

In the substantia propria the globules are limited to the lamellæ and corneal corpuscles, and are not contained in the lymphatic spaces and channels. The droplets are usually larger than those in Bowman's membrane, but the finer punctate appearance is seen around the larger drops. The largest drops are from 5—10 μ in length, and about half the width, the long axis being in the direction of the lamellæ, *i.e.*, more or less concentric with the surface of the cornea. This is due doubtless to the conditions of tension of the tissues. The smaller globules also show a similar disposition to be arranged in layers in the same direction; they are invariably punctate or spherical.

Tangential sections demonstrate that minute drops are also contained in the cytoplasm of the corneal corpuscles, extending into the processes of the cells, and showing a polar arrangement near the nucleus, as pointed out by His and Virchow.

Immediately beneath Bowman's membrane the stain is limited to the same extent, but each succeeding lamella is affected a little farther towards the periphery, so that in transverse sections a kind of staircase arrangement is seen. The deeper layers are usually less affected towards the centre of the cornea, and the density of the deposit also diminishes from before backwards, so that the middle layers of the substantia propria are little stained or not at all. Even under these circumstances, however, there is a further increase in the deepest layers, but the stain is not here so uniformly distributed, with the single exception that it is invariably extremely dense upon the surface of Descemet's membrane. With a low power, and particularly in thick sections, Descemet's membrane seems to be much involved, but with a higher power and in thin sections it is obvious

that it escapes entirely in reality, the dense deposit being only upon the anterior surface.

It is therefore obvious that the clearer peripheral ring of cornea is not entirely unaffected, but is comparatively clear owing to the absence of Bowman's membrane and the slighter implication of the more superficial layers of the substantia propria due to the staircase arrangement.

Beyond the true corneal margin there is a limiting area of sclerotic which I have never seen affected. Beyond this, however, there is frequently some deposition of fatty material in the deeper layers of the sclerotic.

Slight deposition of fat is almost invariably seen in the roots of the ciliary processes. This is probably physiological.

Using Sudan III or Scharlach R as indicators, it is found that the material is insoluble in water, dilute acetic acid, Müller's, Marchi's, Flemming's, and Hermann's solutions, &c., and that it is soluble in absolute alcohol, ether, chloroform, xylol, &c. Thus, after staining with Sudan III and immersion for half a minute in absolute alcohol, scarcely a trace of the stain remained, no globules could be seen, and the lamellæ had the appearance of normal lamellæ. Similar treatment for half a minute in ether resulted in total disappearance of the stain and the arcus. Hence arcus senilis cannot be demonstrated in paraffin or celloidin sections.

The globules can be dissolved out and restained upon the slide. Thus, a section was stained with Sudan III and mounted in 70 per cent. alcohol, covered with a cover-glass, and watched under the microscope. A small quantity of absolute alcohol was placed upon one side of the cover-glass and drawn through by means of blotting-paper. This was followed by a small dose of ether. The stain was rapidly dissolved out. The section was then restained with Sudan III upon the slide, the ether having evaporated. Many oil-globules were seen hanging about the anterior surface of the epithelium, well stained by the dye.

Fresh sections were stained by various solutions con-

taining osmic acid, for varying lengths of time. No definite staining was obtained with 2 per cent. osmic acid, unless it was allowed to gradually dry, in which case the whole section became black. It is known that osmic acid acts best after previous treatment of the sections with hardening reagents—2 per cent. osmic acid, after treatment of the section with 70 per cent. alcohol, failed to stain the deposit. Sections were placed in large quantities of Marchi's solution, Flemming's solution, and Hermann's solution, and examined at intervals from 24 hours to 3 weeks, being mounted in glycerin. In no case was there any true reduction of the osmic acid. The neighbourhood of the arcus certainly showed a blackish appearance, but this was apparently due to a difference in the relative refractility of the globules and the surrounding tissues, for under a high power it was seen that the blackness disappeared on slight alterations of focus. Further, after such treatment the arcus readily dissolved out when treated with ether, leaving no trace behind; and the blackened sections, when mounted in Canada balsam in the usual manner, could not have been distinguished from normal corneæ. There can, therefore, have been no true reduction of the osmic acid.

Fresh sections were treated by Bolton's modification of the Weigert-Pal method (25); *i.e.*, they were placed in 1 per cent. osmic acid for a few minutes, then in ammonium molybdate solution overnight, stained black with Kultschitzky's hæmatoxylin, and differentiated in Pal's solution. By this means the arcus was stained black. The stain was removed on treatment with ether.

Experiments were made to see if the globules contained phosphorus. For this purpose, Macallum's very accurate modification of Lilienfeld and Monti's method was used (26). Sections were immersed in ammonium molybdate solution for 24 hours in an incubator at 35° C.; they were then dipped in 4 per cent. solution of phenylhydrazin hydrochloride, washed in water, stained in Sudan III, and mounted in glycerin. The distribution of phosphorus in the

tissues was admirably shown. The arcus showed no trace, but was well stained by the Sudan III. Sections similarly treated, but not counter-stained with Sudan III, also showed the absence of phosphorus from the globules.

On the hypothesis that the material was fatty, an attempt was made to saponify the fat upon the slide. The section was mounted, without covering, in 70 per cent. alcohol. A small piece of metallic sodium was then placed in the fluid near the section and the reaction watched under the microscope. By this means sodium ethylate ($C_2H_5 \cdot ONa$), with some sodium hydrate (NaOH), was produced. The former is capable of saponifying fats in the cold. A large crop of acicular crystals (? $C_2H_5 \cdot ONa$) was formed, and the globules of the arcus disappeared.

Fresh sections stained with Lugol's solution (iodine dissolved in 1 per cent. solution of potassium iodide) stained the globules yellow, as is the case with most tissues. There was no trace of amyloid reaction.

Remarks.—Canton (27) states that Bowman's membrane is unaltered. This is inaccurate: as shown above, it is the main cause of the densest part of the arcus senilis.

He further states (28) that there is a slight elevation of the cornea at the site of the arcus. This is also inaccurate: but there is an undoubted, though usually slight, diminution in the thickness of the cornea peripheral to the arcus. The contrast probably led to the error. This slight thinning of the cornea outside the arcus points to a condition of sclerosis as a constant accompaniment of the degeneration. If this be so, it is interesting in connection with those rare cases of Peripheral Sclerosis and Peripheral Atrophy (Randsclerose and Randatrophie) which Fuchs (29) has recently described, and which only occur in association with a previously established arcus senilis. In these cases there is marked thinning of the cornea outside the arcus, which may be localised or may involve the whole ring round the cornea. It sometimes leads to ectasia, and consequent axial myopia. It is not usually preceded by inflammation, and is not an

ulceration, but a true sclerosis. It is to be distinguished from transient "Delle," which are described at the periphery, and also from Schmidt-Rimpler's (30) chronic peripheral "Furchenkeratitis," which is central to the arcus. In one of the four cases described by Fuchs, one eye was removed for glaucoma, and was examined microscopically. The sclerosed area formed a complete gutter round the cornea, which was ectatic. Bowman's membrane ceased 2 mm. from the edge, which is perpendicular on the corneal side and sloping on the scleral side. The gutter was 0·55 mm. wide, and the cornea at this part only 0·57 mm. thick. Outside Bowman's membrane the tissue was a looser connective tissue containing blood-vessels, there being a gradual transition from the lamellæ into this tissue. The epithelium was continuous over the surface, being of corneal type to the central edge and conjunctival over the floor, and thicker there owing to protection from pressure. Descemet's membrane was normal. Fuchs speaks of the appearances as indicating a "vorgeschobene Limbus." The same appearance of an invasion of the cornea by the conjunctiva of the limbus, leading to absorption of Bowman's membrane, strikes one when examining an ordinary arcus senilis, but I have been unable to convince myself that Bowman's membrane ends more centrally in these cases than normally. It is difficult, even under the microscope, to accurately fix the limits of cornea and sclera, and the only constant point to measure from is the spot where Descemet's membrane splits up at the ligamentum pectinatum iridis. Measured from this spot, Bowman's membrane does not end appreciably nearer the centre than in the normal eye.

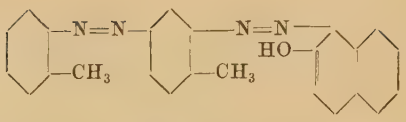
Canton (31) also refers to an encroachment of the conjunctiva upon the cornea, and states that it is greatest at the upper part. He quotes Wharton Jones's (32) accurate observation that the conjunctiva here "appears in its independent form, with its corion fully developed." He also divides the arcus into two parts—"the outer having a grayish-white or dusky tint, the inner one being milky in

colour. These are separated from each other by a clear, unaffected line of cornea, and through which the iris can be distinctly seen." He further quotes Mackenzie (33) as referring to this; and the observation is to some extent substantiated by the deep-lying affection of the sclerotic in Sudan-stained sections.

Canton's illustrations give very accurate representations of what is seen in unstained sections under the microscope, with the exception of the first, in which he depicts the arcus as a pyramidal opacity with the apex downwards, and Bowman's membrane, unaltered, extending far beyond it peripherally.

It is difficult to reconcile my observations with those of Fuchs and Leber, but in all probability they examined later conditions of the affection, or cases in which other degenerative changes were present, masking the true arcus, which would have disappeared in the specimens mounted in Canada balsam.

The conclusions arrived at by Mr. Tweedy and Mr. Treacher Collins are chiefly explicable by the behaviour of the globules to osmic acid. Even Takayasu, whose results I confirm for the most part, states that the globules stain with osmic acid, though with difficulty. I agree that they become blacker, but this is no evidence of a true fat stain, for I have proved that the osmic acid is not reduced. This result introduces a complication into the explanation of the action of Sudan III and Scharlach R. It has been shown by Altmann and others (34) that osmic acid only stains, *i.e.*, is only reduced by fats which are glycerides of the chemically unsatisfied acrylic series of acids ($C_nH_{2n-1} \cdot COOH$), of which olein is the commonest representative in animal tissues. Sudan III was first used by Daddi (35), the idea of its utility for microscopic purposes being derived from the fact that it was used commercially for staining fatty preparations, *e.g.*, pomades, &c. The nature of the dye and of its congener Scharlach R, which is chemically azo-orthotoluol azo-β-naphthol—



(Sudan III having the same formula, except that the two H's have not been replaced by (CH_3) groups) has been worked out by Michaelis (36). He explains their action upon the same principle as that of osmic acid, viz., that reduction of the stain is brought about by the action of fatty acids of the acrylic series. If this is true we should expect osmic acid, Sudan III, and Scharlach R to invariably act in the same manner. This is not the case with arcus senilis, and we are forced to the conclusion, either that there is some flaw in the chemistry of the action of these stains, or what is more probable, that osmic acid is more stable than the aromatic stains, which are reduced by a smaller amount of, or by less potent members of, the acrylic series.

It was thought possible, on account of the common occurrence of cholesterin in senile degenerations, that the fat-like material might be a cholesterin ester, or ethereal salt of a fatty or other acid. These bodies occur in large quantities in lanoline. The supposition was improbable *à priori*, for most cholesterin esters are insoluble in alcohol. On saponification they are split into the acid and cholesterin, which is an alcohol with the formula $C_{27}H_{45}{\cdot}OH$. It was just possible, if they were present, that cholesterin would crystallise out in its typical form upon the slide, when the section was treated with sodium ethylate. This, however, did not occur.

Most fats are not readily soluble in alcohol, and the globules of the arcus senilis show less solubility in it than in ether, but probably more than most fats.

In conclusion it may be stated that the arcus senilis is probably a fatty degeneration of the substantia propria of the cornea, the exact chemical nature of the fatty material being still undetermined.

Bibliography.

(1.) Duddell. A Treatise on the Diseases of the Horny Coat of the Eye, and the various kinds of Cataract, p. 67. London, 1729.
(2.) Plenck. Doctrina de Morb. Oculor., p. 95. Vienna, 1783.
(3.) Meckel. Man. d'Anatomie, Tome iii.
(4.) Walker. Principles of Ophthalmic Surgery, p. 74. London, 1834.
(5.) Hays. Amer. Jl. of Med. Science, vol. iii, p. 337.
(6.) Seiler. Reil's Arch. f. d. Physiol., Bd. vi, s. 72. Halle, 1802.
(7.) Velpeau. Gaz. Méd., Tome i, p. 105. 1839—40.
(8.) Jeaffreson. A Practical Treatise on Diseases of the Eye, p. 122. London, 1844.
(9.) Lawrence. A Treatise on Diseases of the Eye, 3rd ed., p. 356. London, 1844.
(10.) Middlemore. A Treatise on Diseases of the Eye and its Appendages, vol. i, p. 455. London, 1835.
(11.) Schön. Quoted by Lawrence, *loc. cit.*, p. 356.
(12.) Artha. Entwurf einer anatomischen Begründung der Augenkrankheiten, p. 121. Prag, 1847.
(13.) Canton. Lancet, May, 1850.
(14.) ,, The Arcus Senilis. London, 1863.
(15.) Williams. Quoted by Canton (14), p. 18.
(16.) His. Beiträge zur normalen und pathologischen Anatomie der Cornea. Basel, 1856.
(17.) Virchow. Virchow's Archiv, Bd. iv, 1852.
(18.) Castorani. Gaz. Méd., November 14, 1857.
(19.) Fuchs. Archiv. f. Ophth., Bd. xxxvii, Abt. 3, S. 154.
(20.) ,, Text-book of Ophthalmology, 2nd Amer. ed., p. 209.
(21.) ,, Archiv f. Ophth., Bd. lii, Abt. 2, s. 317.
(22.) Leber. In Vossius, Lehrbuch der Augenheilkunde.
(23.) Tweedy. Quain's Dict. of Medicine, art. "Arcus Senilis."
(24.) Takayasu. Archiv f. Augenheilkunde, Bd. xliii, Heft 2, S. 154.
(25.) Bolton. Jl. of Anat. and Phys., vol. xxxii, p. 245; Zeitschrift f. wiss. Mikr., Bd. xv, s. 457.
(26.) Macallum. Jl. of Phys., vol. xxiii, Supp., p. 31.
(27.) Canton. *Loc. cit.* (14), p. 31.
(28.) ,, ,, ,, p. 32.
(29.) Fuchs. *Loc. cit.* (21).
(30.) Schmidt-Rimpler. Lehrbuch d. Ophth., 7te Aufl., S. 491.
(31.) Canton. *Loc. cit.* (14), p. 6.
(32.) Wharton Jones. Cyclop. of Anat. and Phys., art. "Lachrymal Organs."
(33.) Mackenzie. A Practical Treatise on Diseases of the Eye, 4th ed., p. 736. London, 1854.
(34.) See Handwerck. Zeitsch. f. wiss. Mikr., Bd. xv., s. 177.
(35.) Daddi. Arch. ital. de Biol., Tome xxvi, p. 143.
(36.) Michaelis. Virchow's Archiv, Bd. clxiv, S. 263.

A REPORT OF THE CASES IN WHICH HAAB'S MAGNET WAS USED FOR THE EXTRACTION OF FOREIGN BODIES FROM THE EYE AT THE ROYAL LONDON OPHTHALMIC HOSPITAL.

By A. Ferguson MacCallan, F.R.C.S., Eng.,

Senior House Surgeon, Royal London Ophthalmic Hospital.

In the following paper all the cases have been reported in which foreign bodies were removed from the eye, directly or indirectly by Haab's magnet, up to the end of July, 1901. The cases which came under the care of Mr. Holmes Spicer have already been collected and published elsewhere, but it has been thought well to include all the cases in order that a complete report might be given:—

Case 1.—George S. was admitted under the care of Mr. Tay at Moorfields on January 10, 1900. His L. eye had been penetrated by a piece of steel 5 hours before admission. There was found to be a small wound at the inner part of the cornea, and a bead of vitreous was oozing from it. The iris was entangled in the wound. Through a small hole in the iris the opaque lens could be seen. On the following day Haab's magnet was applied by Mr. Collins; this brought the f. b. forwards, presumably from the posterior part of the vitreous, and caused the iris to bulge anteriorly. An incision was made through the sclerotic on the nasal side of the globe behind the ciliary body; the terminal of the small magnet was inserted, and the f. b. was withdrawn.

About a year after the accident there was found to be aphakia. A thickened capsule remained, which was somewhat adherent to the iris; this capsule was needled. With a correcting glass he now gets 6/6 and J. 1.

If in this case localisation by means of X-rays had been carried out, it is probable the f. b. might have been drawn through the opaque lens into the a. c. by Haab's magnet without any necessity for the use of the small magnet.

Case 2.—William R., æt. 28. A piece of steel penetrated L. globe 4 weeks previous to admission. He had attended another ophthalmic hospital, where a small magnet had been tried unsuccessfully, and where excision had been recommended. When seen—December 20, 1899—there was a corneal wound to the inner side, and a nebula just above the centre of the cornea; there were also definite signs of iritis. The lens was clear; there were vitreous opacities. V. L. = fingers at 4 feet. The tension was diminished.

On introducing the patient to Haab's magnet, the f. b. was drawn just over the pupillary border of the iris, but fell back again. Owing to failure of the current the small magnet could not be used, and further operation was deferred. Later, the patient was X-rayed, and the f. b. localised at the back of the vitreous. Haab's magnet being applied by Mr. Holmes Spicer—January 13, 1900—the f. b. was drawn into the a. c. After a corneal section had been made with a keratome, the small magnet withdrew the particle. Some lens matter was curetted; it was also necessary to perform a small iridectomy.

The patient was seen on January 20 of this year. He was found to have a thick capsular membrane, through which the details of the fundus could not be seen. Projection was perfect.

V. L. $\bar{c}$ sph. + 10 = 6/60. Field good.

Case 3.—George B. came to the hospital on May 10, 1901, and was seen by Mr. Flemming in the O. P. Department. He had been chipping a steel bar that morning, when a small piece of metal flew into his L. eye. There was found to be a small corneal wound situated between the centre of the cornea and the highest part of the corneal periphery, there was much injection, there was iritis, and the lens was wounded. The patient was at once taken to the theatre, and Haab's magnet applied. The f. b. was drawn through the lens and through the upper part of the undilated pupil; the iris prolapsed slightly after the exit of the f. b. through the wound, and the prolapse was snipped off. A good deal of inflammation succeeded the operation, and the lens vegetated through a rent in the anterior capsule. In a few days tension became normal, and the eye quieted down. The man was then discharged from the hospital, and kept under

observation in the O. P. Department. On June 16 he was re-admitted into the hospital, as the lens had become broken up to some extent, and it became necessary to remove it. This was accordingly done by curette evacuation. The eye again became quiet, and he was discharged. On July 2 the eye was irritable, and there was some injection; there was also some irritation of the unwounded eye; he was therefore re-admitted for the detachment of an anterior synechia which had formed. At this operation the capsular membrane, which was left after the curette evacuation, was needled, and a free opening was made. The patient was seen again on September 10, 1901, and he was found to read, with correction for his aphakic condition, 6/6 and J. 1.

Case 4.—Charles S., æt. 30, was struck in the L. eye by a chip of steel from the face of a hammer, 14 days before coming to the hospital. When seen by Mr. Holmes Spicer there was much conjunctival injection. In the upper and outer quadrant of the corneo-scleral margin was a wound in which the iris was entangled. The lens was clear. There was much hæmorrhage into the vitreous. V. L. = 6/36. At the outer canthus, beneath the conjunctiva, a small swelling could be seen. The skiagraph, which was taken, localised the f. b. in the region of the swelling about 6 mm. deep. On the day after his admission, May 12, 1900, Haab's magnet was applied to the globe without causing any pain; when applied to the outer canthus the patient experienced pain at once, and the conjunctiva bulged forward. The conjunctiva was divided over the region of the swelling, and extraction with the small magnet was attempted without success. On again applying Haab's magnet the foreign body appeared between the lips of the conjunctival wound, and was extracted with forceps. He was discharged from the hospital on May 21. V. L. = 6/60, when the condition was:—Fundus obscured by vitreous hæmorrhages; iris still somewhat adherent to the corneal wound. The patient was seen on February 23, 1901, when V. was found to be 6/6, partly. There was a large scar in the outermost periphery of the fundus. In this case the f. b. must have passed through the corneo-scleral ring, the ciliary body, the vitreous, and the sclerotic.

Size of f. b. = 8·5 mm. × 5·5 mm. × 3 mm.

Case 5.—On May 20, 1901, Henry S. was admitted into the hospital. He had been struck in the R. eye 14 days ago by a piece of steel from the face of a hammer. There was considerable injection, and a small wound in the lower part of the cornea; a small hypopyon was present; there was iritis, and some posterior synechiæ externally. The lens was completely opaque. V. = hand movements. The patient had been X-rayed while an O. P., and a spicule of steel, 3 mm. long, had been detected in the lens behind the iris in the situation where it was adherent to the lens capsule. With a needle Mr. Flemming tore through the anterior capsule of the lens. This manœuvre brought the f. b. into view; a peripheral corneal incision was made, and a terminal of the small magnet was introduced into the a. c. This, however, failed to remove the f. b. The patient was then introduced to Haab's magnet, which withdrew the f. b. without difficulty. The lens matter, which was found to be fairly fluid, was removed by curette evacuation. The patient was discharged after a fortnight with the eye quiet; the pupil was fairly dilated, and there was some soft matter in the pupillary area. Six weeks after the operation, after correction for the aphakic condition, he was able to read 6/9 and J. 1. His field, as taken by the perimeter, was normal.

Case 6.—Wm. B., æt. 42, first came to the hospital on September 9, 1897, having been struck in his L. eye with a piece of steel from a tool 10 weeks before. There was a scar on the cornea, the lower part of the lens was opaque, no details of the fundus could be seen. The eye remained quiet, and he was watched for a period of three months; no operation was thought advisable, as there was no evidence of the presence of a foreign body in the eye, and he ceased to attend. He returned to the hospital in September, 1899. On examination the eye was quiet; the lens was partly opaque; a red reflex was obtained from the upper part of the fundus, but no foreign body was seen. On November 3, the f. b. was localised by the aid of X-rays in the globe, situated on a horizontal plane, running 1 mm. below the lower margin of the cornea, and 7 mm. back from the plane of the centre of the cornea, almost in the middle line. On November 5, the condition of the eye was as follows:

Some general conjunctivitis; no visible wound; pupil irregular but active; lens opaque; no red fundus reflex. The patient was under the case of Mr. Holmes Spicer. On introducing the patient to Haab's magnet the f. b. was drawn into the a. c. and removed by the small magnet, after a corneal section had been made. The patient was discharged at the end of a week with the eye in a perfectly quiescent condition. On December 19 he was readmitted. The pupil was irregular, but fairly active. The lens had absorbed and a dense capsular membrane in the pupillary area remained. No details of the fundus could be seen.

V. L. $\bar{c}$ sph. + 10 = 6/60 T. = normal. Projection good. The capsule was needled, and a good central opening made. The patient continued to attend as an out-patient till February 10, 1900, when his V. L. was $\bar{c}$ + 13 D = 6/9.

Case 7.—Thos. T., æt. 27, on May 23, 1900, the L. globe was penetrated by a chip of steel from a lathe. He had had very little pain or inconvenience since the accident. When seen at Moorfields on July 1, by Mr. Holmes Spicer, he was found to have a corneal scar, and a traumatic cataract. The pupil was dilated under atropine, and the eye was fairly quiet. No red reflex was obtained from fundus. V. L. = hand movements. A f. b. was localised by the aid of X-rays in the vitreous 1·3 c.m. behind the centre of the cornea.

On July 4, the extraction of the f. b. was attempted. The patient's head being put on a level with, and at a distance of a few feet from Haab's magnet—the electric current was switched on gradually. At the same time the patient's eye was approached to the terminal, and he at once experienced pain. The f. b. was seen to come forward through the lens, and to take up a position on the lower pupillary border of the iris.

The patient, who had previously been sitting on a stool in front of the magnet, was transferred to the operating table. At this point the foreign body disappeared from view. An incision was made with a keratome at the lowest part of the corneo-scleral ring. The curved terminal of the horse-shoe magnet was introduced into the a. c., and the f. b. was drawn over the pupillary border of the iris, and removed. Some lens matter was evacuated

with a curette; a little infiltrated vitreous was also removed. On the patient's discharge, July 15, the eye was quite quiet, and the remainder of the lens matter was becoming absorbed.

On December 10, Dr. Edgar Stephenson, of Liverpool, under whose care the patient originally was, most kindly sent me a note as to his condition. The pupil was quite clear; the lens matter was all absorbed, but there were some capsular remains in the periphery.

$$V\ \bar{c}\ \text{sph.} + 11\ D = 6/9.$$
$$\bar{c}\ \text{sph.} + 15\ D = J.\ 1.$$

The patient had been back at work for some months, and has had no trouble of any kind with his eye.

Size of f. b. = (6·5 × 2 × 1) mm.

Case 8.—Manning H. was struck in R. E. by a chip when using hammer and chisel on April 30, 1901. He came to the hospital on May 4, and was admitted under the care of Mr. Lang. The eye was quiet; there was a small corneal wound in the upper and inner quadrant of the cornea near its margin. There was no iritis, the lens was opaque. On May 8 the f. b. was localised accurately by the X-rays. It was found to be behind the lens on its nasal side, about the level of the lower border. The pupil was dilated with atropine but full mydriasis was not obtained. The f. b. was drawn forwards from its position by Haab's magnet to the lower and inner quadrant of the iris where a bulging was produced. All attempts to disengage the f. b. from the iris and bring it into the pupillary area failed during the use both of Haab's and the small magnet. The patient was placed upon the table and a peripheral incision was made with the keratome below, at the corneo-scleral junction. Iris and f. b. at once prolapsed. The f. b. was removed with the small magnet and a small iridectomy was done. On the 15th June, with a low astigmatic correction, the patient read 6/6 and J. 1. The condition of the eye was as follows:—The iris was adherent below to the keratome wound, there was some slight lenticular opacity—and very fine vitreous opacities. The patient complained of some asthenopia when reading.

Case 9.—Thomas C., æt. 47, was admitted to Moorfields under the care of Mr. Treacher Collins, on May 14, 1900.

Three weeks previously a steel splinter had penetrated the L. eye while chipping brickwork. He had pain at the time and this was getting worse. Many years previously he had had an injury to the same eye which left a small scar in the sclerotic, at the inner side of the cornea. On examination he was found to have some injection of the conjunctiva. There was a wound in the upper hemisphere of the cornea. Corresponding to this was a notch on the edge of the iris. V. L. = 6/60. The patient was introduced to Haab's magnet, which caused the f. b. to traverse the lens and bulge forward the iris. This occurred after several separate trials of the magnet.

A corneo-scleral incision was made with a keratome, and an attempt was made to extract the f. b. with the horse-shoe magnet. This was unsuccessful because the piece of steel had fallen down behind the iris and was not in the a. c. The patient was then anæsthetised, an iridectomy was done, and the f. b. was removed with the small magnet. As a result of the operation a traumatic cataract developed. He was admitted for the extraction of this on October 17, 1900; this was done, with iridectomy, and in due course he was discharged from the hospital. I saw him again at the end of January of last year; in the pupillary area there was fine capsule, to which the iris was adherent in places, the fundus was healthy, the field was good. The refraction, as obtained by retinoscopy, was + 18 D.

V. L. $\bar{c}$ sph. + 17 D = 6/12. $\bar{c}$ sph + 21 D = J. 1.

In this case the f. b. was not located by X-rays. Had this been done injury to the lens might have been avoided.

Case 10.—Edward G. was admitted under the care of Mr. Collins, on August 29, 1901. He had been wounded in the R. E. by a chip of metal from a steel hammer a week previously. There was a wound in the ciliary region, and hæmorrhage into vitreous and a. c. It was not known whether the f. b. was present or not.

The patient was introduced to Haab's magnet and the sclerotic was seen to bulge slightly in the neighbourhood of the old wound. An incision was made through the sclerotic at this point and the f. b. was removed by the small magnet.

A little vitreous was lost.

I saw the patient a month after the operation; the lens was clear, and V. = 6/12. In this case, although the actual removal of the f. b. was effected by the small magnet, Haab's magnet played the chief part. The f. b. previous to operation occupied an unknown position in the vitreous, whence it was drawn into such a situation that the use of the small magnet became possible (after an incision in the sclerotic had been made) without disturbing the vitreous by its terminal. In fact, before Haab's magnet was applied it was not actually known that any f. b. was present in the globe.

Case 11.—Wm. N., æt. 16, under the care of Mr. Holmes Spicer. On March 16, 1900, a piece of steel flew into the patient's L. E. from a chisel. He was found to have a scar at the outer part of the cornea, a hypopyon, and iritis. Both cornea and lens had been wounded; there was a dull red fundus reflex only; projection was good. V. = hand movements.

On March 20 the hypopyon had disappeared. The f. b. was localised in the vitreous, 1·2 cm. behind the centre of the cornea, and 4 mm. to temporal side. A few days later the patient was introduced to Haab's magnet, and the f. b. was drawn (without further wound of the lens) into the a. c. through the lower periphery of the iris. Probably it came through the zonule. A section was made with a keratome, and on inserting the curved terminal of the horse-shoe magnet, the f. b. adhered to it, and was removed. When the patient was seen eight months later the condition was as follows:—An anterior synechia at the site of the corneal wound; an active pupil, and some anterior and posterior capsular opacity of the lens. After correction of hypermetropia patient could read 6/12 partly.

The patient now follows his trade of carpenter with ease.

Case 12.—Fredk. C. was admitted to Moorfields under the care of Mr. Tay, in September, 1900. He said that two days previously he had been struck in R. eye by a piece of metal. The L. eye had been excised 10 years ago, at Moorfields, as the result of an accident. On examination there was found to be a hypopyon and iritis. The f. b. was seen to be lying on the iris. There was a wound in the lower part of the cornea. The small magnet was tried unsuccessfully by Mr. Lawson, the terminal

being inserted through the corneal wound. The patient was then introduced to Haab's magnet. By its attraction the f. b. was caused to emerge slowly from the corneal wound. The patient was discharged from the hospital on October 10. Vision was then 6/18 after correcting some astigmatism.

I saw the patient on January 31, 1901. He complained of pain at night, and during the day he had sensations of "smoke" in his eye. He was led about by his wife and professed to be entirely unable to find his way about alone, although he avoided obstacles when the guiding hand was removed. The V. was 6/36 slightly improved with correcting glass. Vision of this degree would certainly enable the possessor to steer clear of large obstacles when walking about. There was very slight opacity of the lens, but the fundus could be distinctly seen. It appeared to be healthy except for a few spots at the macular region—of lighter colour than the surrounding fundus—probably significant of colloid degeneration. His field of vision was taken and proved to be remarkably small. It was entirely included in the 20 mm. circle of the perimeter chart. It appeared that the patient was making a claim against his employers for the damage he sustained by his accident.

From what has been said above one conjectured that the man was a malingerer, especially as on the next occasion when he was seen—about a month later—the vision had improved to 6/24 with the same correction, although the field was even smaller than before. The tension was normal.

Case 13.—Alice C., æt. 97, was admitted under the care of Mr. Morton, August 2, 1900. Three years previously a piece of steel had penetrated R. E. For about a year before her admission she had had some inflammation in the injured eye, but no affection of the other. On examination there was found to be a scar in the outer part of the cornea, with a small piece of steel embedded, projecting into the a. c. and touching the iris. The pupil was semi-dilated. There was distinct optic neuritis. V. = 6/24.

The patient was introduced to Haab's magnet, and the f. b. was disentangled from its adhesion to the cornea and iris, and

was attracted into a different position in the a. c. so that it lay free. An incision was made in the cornea and the f. b. was withdrawn by the small magnet. A small iridectomy was performed as there was some adhesion of iris to the wound. The patient was discharged from the hospital on August 13, with the eye quiet.

She was seen at the end of October, when there was apparent paralysis of the R. external rectus; there was also an anterior synechia. On November 12, the squint, previously so marked, had disappeared. There was no optic neuritis now present —V $\bar{c}$ hypermetropic correction = 6/18.

Case 14.—Wm. L. was seen by Dr. Rayner Batten on May 14, 1900, to whom I am indebted for these notes. He said that three days previously he had had a blow on the L. E. with a chip of metal from a chisel. A linear wound of the cornea was present, with a corresponding wound of the iris beneath. The lens was partially opaque, V = P. L. T = −1. On May 15 there was a small hypopyon and iritis; on this day Dr. Rayner Batten brought the patient to Moorfields, where the f. b. was localised in the vitreous by X-rays. The patient was introduced to Haab's magnet by Mr. Lang, and after several trials the iris bulged forward at its lowest part. An unsuccessful attempt was made to draw the f. b. over the iris into the a. c. The patient was then anæsthetised. After a corneal section had been made an iridectomy was done, and the f. b. was removed with the small magnet. Some opaque fibrous-looking tissue was removed at the same time, which appeared to have encapsuled the f. b.

On the 24th of the same month the patient was discharged from Moorfields, and returned to Dr. Batten's care. On February 11, 1901, Dr. Batten, at the Western Ophthalmic Hospital, removed the opaque lens.

On March 7, V $\bar{c}$ correction was found to be 6/36. There was thickened capsule in the pupillary area.

It is to be noted that the patient had divergent strabismus, and that the injured eye was the non-fixing one.

Case 15.—Mark A. was admitted to Moorfields saying that he had had an accident with a piece of steel to his L. E. on the previous day. There was a wound of the sclerotic to the inner

side of the cornea; there was mydriasis, probably due to the use of atropine; inflammatory reaction was not particularly marked. On ophthalmoscopic examination a f. b. was seen lying in the vitreous with its long axis nearly vertical. The posterior edge seemed to be in close relation with the fundus, the details of which were obscured by vitreous opacity. V. L. = 3/60.

On July 27, 1900, the day after the patient's admission, an incision was made by Mr. Marshall through the sclerotic to the temporal side of the ciliary body. Several attempts were made to withdraw the f. b. by inserting the terminal of the small magnet, but these were unsuccessful.

Mr. Marshall then introduced the patient to Haab's magnet, which at once withdrew the chip of steel from the scleral wound. I saw the patient on January 26, 1901; his vision was then 6/36. There were some striæ in the lens, and some slight vitreous opacity. To the outer side of the disc was an area of old choroido-retinitis; this corresponded with the site of the f. b.

Case 16.—Albert P., under the care of Mr. Spicer, came to the out-patient department complaining that a piece of steel had struck his R. E. He thought that nothing remained in it. He said that the fragment was ½ inch long, and had been found on the ground after the accident. On examination there was seen to be slight conjunctival injection, a vertical wound in the outer hemisphere of the cornea, and some iritis. The lens was becoming opaque. V. R. = Hand movements. The tension was diminished. He was treated as an out-patient until April 7. In the interval he was X-rayed, and the f. b. was localised in the vitreous, probably close to the retina. He was admitted to the hospital, and Haab's magnet being applied, the f. b. was drawn into the a. c. The patient was then anæsthetised: with a Graefe knife, a section was made upwards, and the f. b. was extracted with ease by the small magnet. Some lens matter escaped, and some was evacuated with the curette. Iris prolapsing, a small iridectomy was done. The patient was seen January 20, 1901; a shrunken, calcareous capsule was present, which almost entirely blocked the pupil. On either side was seen a faint red fundus reflex.

V. R. $\bar{c}$ sph. + 10 = 6/60.

Size of f. b. = (5·5 × 3 × 2) mm.

Case 17.—Henry J. was struck in L. E. by a chip of iron, October 18, 1900. On October 29 the patient was admitted to the hospital under the care of Mr. Gunn. There were no signs of inflammation. A scar was present in the upper part of the cornea, and corresponding to this there was a small hole in the iris near the pupillary border. Opacities were present in the posterior part of the lens and in the vitreous. An especially large opacity was seen in the uppermost part of the vitreous. This was supposed to be the f. b. V. = 3/60.

On October 31 Haab's magnet was applied, and the f. b. was drawn into the a. c. At the lower and inner periphery of the cornea a section was made with a keratome; through this incision the f. b. was withdrawn with difficulty, owing to its shape, by the small magnet.

On November 3rd, a skiagram showed no f. b. to be present. A week later the eye had quieted down perfectly. In the lowest part of the a. c. there was a small piece of lymph, which probably encapsuled the f. b. The hole in the iris was very apparent, the lenticular opacity had increased slightly. V. = 6/60.

Case 18.—Wm. K. was admitted to the hospital on November 16, 1900, under the care of Mr. Gunn. His R. E. was said to have been struck by a piece of metal six months previously. By the X-rays a piece of steel was localised in the R. eyeball. It was found to be lying vertically behind the posterior surface of the lens in the lower part of the vitreous. The eye was perfectly quiet. It was impossible to decide on the site of the original wound. The pupil was semi-dilated and inactive; the iris was yellowish in colour, but this was probably of no importance, since the irides were said to be heterochromic from birth. On the anterior capsule of the lens were many spots of reddish-yellow pigment. The lens was partially opaque. V. = counted fingers at 1 metre. On November 17 Haab's magnet was applied, and drew the f. b. through the lens, until the iris bulged forwards at its lowest part. The patient was then anæsthetised; a corneal incision was made with the keratome, and the small magnet withdrew the f. b. A small portion of iris, in which the f. b. was entangled, prolapsed and was cut off. The patient was discharged from the hospital on November 22. The pigment on the anterior

surface of the lens had increased. No view of the fundus could be obtained, owing to the lenticular opacity, which was situated at the posterior pole for the most part. The patient was seen again on January 15, 1901, when the lens was opaque; on the anterior capsule the pigment previously seen was still present. Projection was good. Mr. Gunn thought that the pigment probably consisted of oxidised iron; he did not consider it advisable to carry out any operative procedure on the lens for some time.

Case 19.—Charles C. was admitted into the hospital on October 11, 1900, under the care of Mr. Morton, having been struck in the R. E. by a piece of steel from a hammer. He was treated at a provincial hospital for three weeks, and was then advised to come to Moorfields. On examination there was found to be slight ciliary redness, and signs of recent iritis. On the nasal side of the cornea was a small scar with a tag of iris adherent to it. The lens was opaque; V. = hand shadows; projection bad; T. full. The L. E. was normal. On the following day the anterior synechia was divided by Mr. Morton with a Lang's knife. The f. b. was localised by X-rays in the vitreous on the nasal side of the globe at the lowest part.

On October 16 Haab's magnet was applied, and drew the f. b. forwards until the lower part of the iris bulged forwards. The eye was then directed downwards, and the f. b. was drawn by the magnet through the opaque lens into the upper part of the a. c. On the current being broken the f. b. fell to the lowest part of the a. c. An incision was made in the lower part of the cornea, and the terminal of the small magnet was introduced. The f. b., however, lying in the pocket formed by the limbus below the level of the incision, could not be removed. An attempt made with the forceps to withdraw the f. b. also failed. The patient was then introduced to Haab's magnet again, and the f. b. was drawn through the incision which had been made. I saw the patient three months later, the pupil was then irregular, and there were many posterior synechiæ. There was a dense band of fibrous tissue running vertically across the pupillary area; a faint white reflex only was obtained from the fundus. V. = hand movements. Projection bad.

Case 20.—Fred. O. was admitted to the hospital on June 7,

1900, under the care of Mr. Morton. He said that his L. E. had been injured by a piece of steel about 6 months previously. He had had much inflammation at times, but the reason he came to the hospital was because V. L. was failing. On examination there was found to be a corneal scar over the inner and lower part of the pupil. There was a considerable amount of inflammation, as shown by the conjunctival injection, the keratitis punctata, and the muddiness of the iris, which were present. Granular opacities at the posterior pole of the lens, and floating opacities in the vitreous were also present. V. L. = 6/60 not improved.

A f. b. was localised by X-rays in the vitreous, just behind and below the lens in the mid-vertical line. On the following day the patient was introduced to Haab's magnet, and the f. b. came forwards carrying with it much of the opaque matter which previously had been seen at the posterior pole of the lens. When the current was interrupted the f. b. disappeared from view. The current was again applied, and the f. b. became lightly entangled in the pupillary border of the iris, partially projecting into the a. c. An incision was then made over the site of the f. b., not quite at the periphery of the cornea, and the f. b. was removed with the small magnet. A fold of iris being in close proximity to the wound was seized with forceps and snipped off with de Wecker's scissors.

After a few days there was a greyish reflex from the vitreous. On June 22 the patient was seen by Mr. Morton and Mr. Silcock in consultation, and excision was advised, on the grounds that the injured eye was not likely to be of service for visual purposes, and would probably become a source of danger to its fellow. The operation was, however, refused by the patient. He was therefore discharged from the hospital. On January 20, 1901, I saw the patient again, and found the eye to be fairly quiet. There was a posterior ring synechia, and the pupil was blocked by organised inflammatory exudate. As far as could be seen the lens was clear. There was only a dull reflex from the fundus. The patient was able to count fingers at 1 metre, and his projection was perfect. On April 29 the condition was less favourable, the iris on the left side was very different in colour to that on the right, though there was no actual inflammation

present. Projection was defective: since then I have not seen the patient.

Case 21.—William S. was admitted under the care of Mr. Morton on March 8, 1901. Six months previously his R. E. had been injured by a chip of metal. He had been X-rayed at a general hospital on several occasions, and the f. b. had been located in the globe. An attempt to extract it with the magnet had failed, and excision had been advised.

He then came to Moorfields; there was found to be a small coloboma of the iris up and in, and the iris was adherent to the iridectomy wound. There were posterior synechiæ and the lens was completely opaque. Projection good.

The f. b. was precisely localised in the lens by X-rays. The patient was introduced to Haab's magnet, and on making the current the iris bulged at its lower and inner quadrant. The eye was directed downwards, and a f. b. of large size appeared in the pupillary area. On breaking the current, it partially slipped back behind the iris. The patient was then placed on the table, and a large horizontal incision was made almost in the centre of the cornea. Haab's magnet was applied behind the patient's head while he was on the table, and the f. b. was removed. In size it was 3 × 2 × 1·5 mm. With the f. b. was withdrawn infiltrated vitreous and lens matter. Protruding vitreous and lens matter was snipped off. The eye quieted down, but, in spite of the use of mydriatics, the pupil became small, and the iris contracted adhesions with the capsule of the opaque lens. I have been unable to communicate with the patient to ascertain his present condition, but as nothing further has been heard of him we may suppose that the eye is still quiescent.

Case 22.—Harry H. was admitted into the hospital under the care of Mr. Tay, March 20, 1900, with a history of a scale from an anvil at which he had been working, striking R. E. on previous day. The same eye had been injured in 1886, and the traumatic cataract which resulted had been removed by needling and curette evacuation. On admission the f. b. was seen in the lowest part of the a. c.; the wound of entrance was situated in

the cornea above and to the inner side of the present site of the f. b.

The patient was at once taken to the theatre, and the f. b. was drawn into the upper part of the a. c. without difficulty by Haab's magnet. With a keratome an incision was made at the outer margin of the cornea, and the f. b. was removed with the small magnet. The patient was kept in the hospital for 6 or 7 hours, and was then sent out owing to lack of vacant beds.

He attended as an O. P., and convalescence was soon established.

On December 26, 1900, after an absence from the hospital of some duration, he came up and was found to have vesicular keratitis and increased tension in R. E.

On February 25, 1901, cornea was much clearer, and the pain which had previously been present was diminished.

V. = hand movements. Tn. Since then the patient has not been seen.

The following cases resulted in excision of the injured globe. They will therefore be considered as briefly as possible :—

Case 23.—Wm. M. (under the care of Mr. Lawford in 1899). Haab's magnet in this case drew the f. b. through the opaque lens into the a. c. It was removed thence *viâ* the original wound by the small magnet, and at the same time some lens matter was curetted. This operation was performed on the second day after the injury. Later a second curette evacuation was performed, and the eye was excised a few days afterwards in a condition of panophthalmitis.

Case 24.—(Under the care of Mr. Lawford in 1899.) At the time of operation in this case the aqueous was leaking through a corneal wound ; there was iritis, and the lens was opaque. Haab's magnet was used to draw the f. b. into the upper part of the a. c., and the small magnet to extract it thence. A hypopyon developed, but inflammatory manifestations subsided in a few days, and the case seemed to be going on well. After some days there was found to be no P. L., and the eyeball was accordingly removed. When the globe was examined, the vitreous was found to be shrunken and invaded by a purulent exudate.

Case 25.—(Wm. C., under the care of Mr. Marshall.) Here the injury occurred two days before the patient came to the hospital. There was considerable inflammation, and the lens was opaque. Haab's magnet withdrew the f. b., and iris prolapsing in its wake an iridectomy was performed. Two days after the operation the projection of light was defective and the tension was low. On the day after the operation, the patient insisted on being discharged from the hospital. He returned the next day in pain, and Mr. Marshall excised the eye. On examining the globe the vitreous contained a stringy band running from the ciliary body below to the original site of the f. b. in the retina. The retina was not detached.

Case 26.—(Chas. P., Mr. Fisher.) The patient's eye had been injured 4 days before the date of extraction of f. b. by Haab's magnet. The f. b. was localised by the X-rays in the vitreous; by Haab's magnet it was drawn through the clear lens into the a. c. A peripheral corneal section was made with a keratome, and the small magnet was used to remove the f. b. thence. The eye quieted down fairly well, and the patient was discharged. Two months after the operation there was a little redness of the conjunctiva and epislera localised to the neighbourhood of an anterior synechia. The eye was soft, and vision was only hand movements. Accordingly Mr. Fisher advised excision, which was performed. On examining the globe the retina was found to be detached and to be adherent to the infiltrated track in the vitreous which marked the path of egress of the f.b.

Case 27.—(Wm. W., Mr. Marshall.) In this case the injury occurred the day before admission. There was iritis and a traumatic cataract. He had never seen well with the eye. Haab's magnet removed the f. b. through the corneal wound. Ten days after operation the lens capsule and iris were found to be adherent to the wound. An iridectomy and a partial curette evacuation were done. Later it was found that the globe was shrinking, the lens capsule was still entangled in the wound, and vision was merely shadows. The eye was therefore excised. On examination the vitreous was found to be shrunken.

Case 28.—(Wm. B., Mr. Morton.) The injury occurred the

day before the operation; there was iritis and a traumatic cataract. Haab's magnet removed the f. b. through the corneal wound. A fortnight after the operation injection persisted and a capsular synechia, which was present, was divided. A fortnight later an iridectomy was done, and an abortive attempt was made to divide the still present synechia. A month after the operation the eye was still much inflamed and was excised. On examination of the eye the vitreous was found to be infiltrated and shrunken, and the retina detached in places.

Case 29.—(David A., Mr. Collins.) Injury 2 days before admission when there was much iritis and a hypopyon. The pupil was blocked with lymph. The f. b. was localised in vitreous by X-rays. Haab's magnet drew the f. b. forwards until the iris was bulged. A small iridectomy was done and the small magnet was inserted through the wound without result. Haab's magnet then removed the f. b. A week after the operation there were the clinical signs of suppuration in the vitreous. Accordingly the contents of the sclerotic were eviscerated and a glass globe was inserted.

Case 30.—(Frank P., Mr. Spicer.) The injury occurred the day before the operation when there was slight conjunctival injection, a prolapse of iris through the corneal wound, and a traumatic cataract. Haab's magnet removed the f. b. and the prolapse of iris was snipped off. A little soft lens matter, which seemed to be mingled with vitreous, welling from the wound was cut off. A violent iritis followed the operation and the tension became raised. Some lens matter was removed by curette evacuation and the a. c. was washed out with saline solution, but in spite of this excision became necessary and was performed. On examination the retina was found to be detached, and under it there was a purulent exudate.

Case 31.—(Robert S., Mr. Marshall.) The injury occurred the day before operation. There was much injection, a patent corneal wound, and a traumatic cataract. Haab's magnet removed the f. b., which was followed by a bead of infiltrated vitreous. The injection which was present after the operation did not subside. At different times three operations were per-

formed without benefit. They were:—Needling, curette evacuation, and division of anterior synechia. Finally excision was performed. On examining the excised globe the vitreous was found to be shrunken and to contain a large blood clot.

Case 32.—(Herbert A., Mr. Marshall.) The injury occurred 5 days before operation. By X-rays a piece of steel $\frac{3}{4}$ inch long was located in the vitreous. This was removed by Haab's magnet through the original scleral wound which had to be enlarged for the purpose. As was to be expected excision became necessary later on.

Case 33.—(Wm. M., Mr. Spicer.) This patient came to the hospital with a history of injury to the R. E. by a piece of metal early on the same day. There was a corneal wound which had not closed. The iris was entangled in the wound and was in a state of acute inflammation. The lens was opaque. The patient was introduced to Haab's magnet the same day, which drew the f. b. into the a. c. Through the reopened wound the small magnet removed the particle.

Some days after the operation, which was followed by considerable hæmorrhage, the iris was found to be entangled in the wound. The eye was in an irritable condition, and was considered to be a source of danger to its fellow. Mules' evisceration operation was therefore performed.

Case 34.—(Charles G., Mr. Spicer.) This patient was admitted 2 days after the penetration of a piece of steel into his L. E. He had much conjunctival discharge; the cornea was hazy, and there was a small central wound. There was marked iritis.

The f. b. was removed on the same day by Haab's magnet by way of the original wound. On the following day, the inflammation having become more acute, the edges of the wound were touched with the galvano-cautery. The eye appeared likely to become a source of danger to its fellow, and Mules' operation was accordingly performed a week after the date of injury.

In the following cases Haab's magnet failed to remove the f. b.:—

Case 35.—Under Mr. Silcock in 1899. Here the injury was of 3 days' standing when the patient came to the hospital. There was a hypopyon and iritis. Haab's magnet caused great pain when the patient was introduced to it, but did not remove the f. b. The eye was excised, and the f. b. was found to be firmly entangled in the ciliary body.[1]

Case 36.—Joseph B. (under Mr. Gunn) was admitted November 29, 1900. About 3 months before his L. E. had been injured by a chip of metal. The lens was completely opaque and there were posterior synechiæ; the eye was quiet. Haab's magnet was tried but without other result than causing some pain. The small magnet was also tried without success. The eye was therefore excised, and in it a f. b. was found encapsuled in lymph and adherent to the ciliary body. It was in the position indicated by the X-rays localisation which had been previously carried out.

Case 37.—James N. (under the care of Mr. Collins) was injured by a piece of steel on the day of admission, March 9, 1901. There was intense chemosis, iris was prolapsed through corneal wound, and the lens was opaque. Haab's magnet was applied at once by the House Surgeon without result. Two days later the iris was freed by Mr. Collins and the small magnet was tried unsuccessfully. By X-rays a large piece of metal was found to be embedded at the back of the globe and to be projecting through the coats of the eye into the orbit. Haab's magnet when tried directly in front of the patient elicited no pain, but when the pole was placed in the temporal region the patient felt pain. The eye was excised and the f. b. was found in the position described in the X-ray report. Its size was:— $14{\cdot}5 \times 11 \times 1{\cdot}5$ mm.

The damage done to the eye was such that the House Surgeon did not consider it worth while to remove the prolapsed iris, as he thought that excision would eventually be necessary.

Case 38.—Robert B. was admitted to the hospital on June 18, 1900. He had been struck in L. E. by a piece of steel when at work 3 weeks previously. He had been attended during this time by a country doctor. He then went to see

Dr. Johnson Taylor of Norwich, who sent him to Moorfields. The R. was a blind, shrunken eye. On admission the eye was found to be in a markedly inflamed condition. There was a small scar in the outer and lower part of the cornea. The a. c. was occupied by a small hypopyon. The pupil was semi-dilated by atropine. In the anterior part of the lens were some small opacities. By focal illumination an opaque yellowish mass could be seen in the vitreous; there was no red reflex. V. = hand movements. Projection defective. Tension diminished.

On the following day Haab's magnet was tried. Much pain was caused and the patient became collapsed. Further operation was therefore deferred.

By X-rays the f. b. was localised in the lower part of the vitreous, in the middle line behind and below the lens.

On June 22, the patient was anæsthetised. Haab's magnet was applied but without a successful result; there was considerable difficulties in applying the magnet, since its movement is rotary in a horizontal plane only, and it is, therefore, difficult to approximate the pole to the eye of a patient who is in a horizontal posture. Finally the f. b. was removed without difficulty after a scleral opening had been made. The eye became quiet and the patient was discharged from the hospital. Dr. Johnson Taylor saw the patient on January 18, 1901, and was kind enough to inform me as to the condition of the eye, viz.,—that the globe was shrunken, that the lens was opaque, and that there was no perception of light. Size of f. b. 2·5 × 2 × 1 mm.

In the last four cases it has been said that Haab's magnet failed to remove the piece of steel present in each case. There were, however, definite causes for this failure. In the first two cases the foreign body was encapsuled and adherent to the ciliary body. In the third case the piece of steel was very large, and was firmly wedged in a rent in the sclerotic. In the fourth case the difficulty in manipulating the magnet with the patient in a supine posture has been described. In every case the patient experienced pain during the application of the magnet. The sensation of pain is a constant occurrence when a patient, with a magnetisable particle in his eye, is brought up to Haab's magnet, and is of diagnostic

value, for if there is no pain, the eye may be supposed to contain no magnetisable particle.

There has been only one possible exception to this rule in the cases at Moorfields, and in this particular instance there was no proof that the f. b. was of magnetisable nature. The case was under the care of Mr. Collins. Ophthalmoscopically a f. b. could be detected near the retina, but Haab's magnet when applied was without effect. X-rays confirmed the presence of a f. b., and Haab's magnet, again applied, did not cause any pain.

Case 39.—Geo. G., under the care of Mr. Tay, was not seen until 2 days after the injury, when there was much chemosis of conjunctiva and a large hypopyon. There was no P. L. Haab's magnet removed a f. b. through a corneal incision. Excision was necessary later. Size of f. b. 2·5 × 1·25 × 0·5 mm.

The first 34 cases, in each of which Haab's magnet was instrumental in removing a f. b. from the eye, may be tabulated as follows:—

No.	Patient.	Surgeon.	X-rays.	Operations.	Further operations.
1	Geo. S. ..	Mr. Tay ..	No	Haab's magnet. Small magnet	Needling .. ..
2	Wm. R. ..	Mr. Spicer ..	Yes	Haab's magnet. Small magnet. Curette evacuation. Iridectomy	.. ..
3	Geo. B. ..	Mr. Flemming	No	Haab's magnet. Iridectomy..	Curette evacuation Needling.
4	Chas. S. ..	Mr. Spicer ..	Yes	Haab's magnet..	.. ..
5	Harry S. ..	Mr. Flemming	Yes	Haab's magnet..	Curette evacuation
6	Wm. B. ..	Mr. Spicer ..	Yes	Haab's magnet. Small magnet	Needling .. ..
7	Thos. T. ..	Mr. Spicer ..	Yes	Haab's magnet. Small magnet. Curette evacuation	.. ..
8	Manning H.	Mr. Lang ..	Yes	Haab's magnet. Small magnet. Iridectomy	.. ..
9	Thos. C. ..	Mr. Collins ..	No	Haab's magnet. Iridectomy. Small magnet	Extraction & iridectomy.
10	Edwd. G. ..	Mr. Collins ..	No	Haab's magnet. Small magnet. Iridectomy	.. ..
11	Wm. Neve..	Mr. Spicer ..	Yes	Haab's magnet. Small magnet	.. ..
12	Fred. C. ..	Mr. Lawson ..	No	Haab's magnet..	.. ..
13	Alice C. ..	Mr. Morton ..	No	Haab's magnet. Small magnet. Iridectomy	.. ..
14	Wm. L. ..	Mr. Lang ..	Yes	Haab's magnet. Iridectomy. Small magnet	Curette evacuation
15	Mark A. ..	Mr. Marshall	No	Haab's magnet. Scleral incision	.. ..
16	Albert P. ..	Mr. Spicer ..	Yes	Haab's magnet. Small magnet. Curette evacuation. Iridectomy	.. ..
17	Henry J. ..	Mr. Gunn ..	No	Haab's magnet. Small magnet	.. ..

Site of f. b.	Size of f. b.	Vision.	Remarks.
Vitreous ..	.. ..	$\bar{c}$ correction 6/6 J. 1..	Traumatic cataract absorbed spontaneously.
Vitreous ..	.. ..	$\bar{c}$ correction 6/60	Patient is aphakic. There is a thick capsular membrane. Projection and field good.
Vitreous ..	5 × 2·5 × 1 mm. ..	$\bar{c}$ correction 6/6 J. 1..	Traumatic cataract.
Outside sclerotic	8·5 × 5·5 × 3 mm. ..	6/6	F. b. traversed ciliary body vitreous and sclerotic, to reach its resting-place.
In lens ..	1·5 × 1 × ·5 mm. ..	$\bar{c}$ correction 6/9 J. 1..	Small magnet failed.
Vitreous ..	.. ..	$\bar{c}$ correction 6/9 ..	Traumatic cataract absorbed spontaneously.
Vitreous ..	6·5 × 2 × 1 mm. ..	$\bar{c}$ correction 6/9 J. 1..	
Vitreous ..	4 × 1·25 × 5 mm. ..	$\bar{c}$ astigmatic correction 6/6 J. 1.	
Vitreous ..	1·5 × 1 × ·5 mm. ..	$\bar{c}$ correction 6/12 J. 1	Clear lens was wounded at operation.
Vitreous ..	3 × 2·5 × 2 mm. ..	6/12	Some vitreous lost.
Vitreous ..	.. ..	$\bar{c}$ correction 6/12 ..	Traumatic cataract.
Entangled in iris	4·5 × 1·75 × 1 mm...	$\bar{c}$ correction 6/18 ..	Vision deteriorated to 6/36. Malingerer. Lens unwounded.
Entangled in iris	2·5 × 1·5 × 0·5 mm.	$\bar{c}$ correction 6/18 ..	There was optic neuritis at time of operation. Patient seen 3 months after operation.
Vitreous ..	4 × 1·25 × 0·5 mm...	$\bar{c}$ correction 6/36 ..	Advergent eye, thick capsular membrane remains. Traumatic cataract.
Vitreous ..	4·5 × 2·25 × 1 mm..	6/36	Small magnet failed to withdraw f. b. Choroidal atrophy.
Vitreous ..	5·5 × 3 × 2 mm. ..	$\bar{c}$ correction 6/60 ..	Patient is aphakic. There is a thick capsular membrane. Projection and field good.
Vitreous ..	2 × 1·5 × 1 mm ..	6/60	Opacities in lens present before operation increased afterwards.

No.	Patient.	Surgeon.	X-rays.	Operations.	Further operations.
18	Wm. K ..	Mr. Gunn ..	No	Haab's magnet. Small magnet. Iridectomy	.. ..
19	Charles C...	Mr. Morton ..	Yes	Division anterior synechia. Haab's magnet	.. ..
20	Fred. O. .	Mr. Morton ..	Yes	Haab's magnet. Small magnet. Iridectomy	.. ..
21	Wm. S. ..	Mr. Morton ..	Yes	Haab's magnet..	.. ..
22	Harry H. ..	Mr. Tay ..	No	Haab's magnet. Small magnet	.. ..
23	Wm. M. ..	Mr. Lawford	No	Haab's magnet. Curette evacuation	Curette evacuation
24	—	Mr. Lawford	No	Haab's magnet. Small magnet	.. ..
25	Wm. C. ..	Mr. Marshall	No	Haab's magnet. Iridectomy..	.. ..
26	Charles P...	Mr. Fisher ..	Yes	Haab's magnet. Small magnet	.. ..
27	Wm. W. ..	Mr. Marshall	No	Haab's magnet..	Iridectomy Curette evacuation
28	Wm. B. ..	Mr. Morton ..	No	Haab's magnet..	Division synechia Iridectomy
29	David A....	Mr. Collins ..	Yes	Haab's magnet. Iridectomy..	. ..
30	Frank P. ..	Mr. Spicer ..	No	Haab's magnet. Iridectomy..	Curette evacuation
31	Robt. S. ..	Mr. Marshall	No	Haab's magnet..	Needling. Curette evacuation
32	Herbert A.	Mr. Marshall	Yes	Haab's magnet..	Division synechia..
33	Wm. M. ..	Mr. Spicer ..	No	Haab's magnet. Small magnet	.. ..
34	Charles G.	Mr. Spicer ..	No	Haab's magnet..	.. ..

The removal of a f. b. from the a. c. or from the lens, without causing irretrievable damage to the eye, is an easy matter compared with the removal of a f. b. from the vitreous. In the majority of cases in which Haab's magnet was used,

Site of f. b.	Size of f. b.	Vision.	Remarks.
Vitreous ..	1·5 × 1 × ·5 mm. ..	Hand movements ..	Traumatic cataract to be dealt with later.
Vitreous ..	2·25 × 2 × 1 mm. ..	Hand movements ..	Small magnet failed. Traumatic cataract. Retina probably detached.
Vitreous ..	4·5 × 4 × 1·5 mm. ..	Counts fingers at 1 metre	Iritis and cyclitis at time of operation. Lens clear.
Vitreous ..	3 × 2 × 1·5 mm. ..	.. ..	Traumatic cataract.
Entangled in iris	.. ..	Hand movements ..	An old injured aphakic eye. When last seen some months ago patient had vesicular keratitis.
Vitreous ..	.. ..	Excision.	
Vitreous ..	.. ..	Excision.	
Vitreous ..	5 × 3·5 × 2 mm. ..	Excision	Iritis at time of operation.
Vitreous ..	3·5 × 2·25 × 1 mm. .	Excision	Shrunken globe, excised 2 months after operation.
Vitreous ..	7 × 1·5 × 1 mm. ..	Excision.	
Vitreous ..	6·5 × 4 × 1 mm. ..	Excision.	
Vitreous ..	2 × 1·5 × 1 mm. ..	Evisceration	The small magnet failed. Iritis at time of operation.
Vitreous ..	6 × 2·5 × 1 mm. ..	Excision.	
Vitreous ..	4·5 × 3 × 1·25 mm. .	Excision.	
Vitreous ..	20 × 5·5 × 3 mm. ..	Excision ..	f. b.'s of enormous size.
Vitreous ..	15 × 5	Excision ..	
Vitreous ..	3·5 × 3 × 1·5 mm. ..	Evisceration	Iritis.

the f. b. was in the vitreous, and these cases only will be considered further. They are 29 in number, and may be classified according to the visual acuity obtained after operation, as follows :—

(*a*) Those cases which attain to 6/12.

(*b*) Cases in which by further operation, such as extraction of an opaque lens, or needling of a capsular membrane in an aphakic eye, it may be expected that good vision may be attained.

(*c*) Cases in which vision is present, but in which so much damage has been done by the entrance of the f. b. that further improvement of vision cannot be hoped for.

(*d*) Cases in which after operation the eye was excised.

I.

Haab's Magnet Results. (*In Vitreous only.*)

	No. of cases.	Per-centage.
(*a*) Good vision	9	31
(*b*) Vision, with possibilities of improvement	5	17·2
(*c*) „ without „ „	3	10
(*d*) Excisions	12	41·3

From this table it is seen that in 58 per cent. of the cases in which Haab's magnet removed f. b.'s the eyes were saved, and that in half of these cases good vision was obtained.

In the Ophthalmic Hospital Reports, vol. xiv, Mackenzie has given the results obtained by using the small magnet for removing f. b.'s from the vitreous. Only 26 per cent. of the eyes were saved. Mackenzie's paper, however, was written before the days of X-ray localisation, whereas many of the Haab's magnet cases were X-rayed previous to the extraction of f. b.'s. Comparison, therefore, is not quite fair, since the prognosis in magnet extraction cases is more favourable if precise localisation has been carried out before the application of the magnet. It is then possible in many cases so to direct the magnetic force that a minimum of damage is done during the exit of the f. b. from the globe. The damage likely to be caused may be

(*a*) Entanglement of f. b. in ciliary body or iris.

(*b*) The injury of a hitherto unwounded lens,

(*c*) Prolapse of iris,

At Moorfields, the localisation of f. b.'s by the aid of X-rays has been carried out by Dr. Mackenzie Davidson, with great exactness.

A table is given below showing the results obtained in the 14 cases in which the f. b.'s had been localised exactly previous to their removal by Haab's magnet. Localisation was effected by X-rays in all the cases except one, and in this the f. b. could be seen with the ophthalmoscope.

II.

Haab's Magnet Results after X-rays. (*In Vitreous only.*)

	No. of cases.	Per-centage.
(*a*) Good vision	5	34·27
(*b*) Vision, with possibilities of improvement	4	25
(*c*) „ without „ „	2	12·5
(*d*) Excision	3	21·4

From comparison of Tables I and II it is seen that localisation has reduced the percentage of excisions by one-half, and has correspondingly improved the results in the eyes saved.

III.

Comparison of Small Magnet and Haab's Magnet Cases after Localisation. (*In Vitreous only.*)

	Small magnet.		Haab's magnet
	No. of cases.	Percentage.	Percentage.
(*a*) Good vision	3	16·6	34·27
(*b*) Vision, with possibilities of improvement	6	33·3	25
(*c*) Vision, without possibilities of improvement	5	27·7	12·5
(*d*) Excision	4	22·2	21·4

From Table III it is seen that the percentage of excisions as compared with the percentage of eyes saved is about the same with the two magnets, but that the quality

Small Magnet Cases after

No.	Patient.	Surgeon.	X-rays.	Operations.	Further operations.
1	Harry J. ...	Mr. Lang.....	Yes	Scleral incision. Small magnet	..
2	Roland L. ..	Mr. Collins ...	Yes	Scleral incision. Small magnet	..
3	Arthur S. ..	Mr. Collins ...	No	Small magnet	..
4	John M. ...	Mr. Morton . .	Yes	Scleral incision. Small magnet failed	2nd small magnet trial successful
5	James D....	Mr. Morton...	Yes	Small magnet	Curette evacuation
6	Alfred B. ..	Mr. Tay.....	Yes	Small magnet	..
7	John A.....	Mr. Tay.....	Yes	Iridectomy. Small magnet. Curette evacuation	..
8	Thos. B. ...	Mr. Morton ..	Yes	Small magnet.....	Division anterior synechia
9	Henry R. ..	Mr. Collins...	Yes	Scleral incision. Small magnet	..
10	Robt. R. . .	Mr. Silcock...	Yes	Scleral incision. Small magnet	..
11	Henry P....	Mr. Tay.....	Yes	Scleral incision. Small magnet	..
12	James T....	Mr. Lawford..	Yes	Scleral incision. Small magnet	..
13	Alfred M...	Mr. Tay.....	Yes	Scleral incision. Small magnet	..
14	James F....	Mr. Tay.....	No	Scleral wound. Small magnet	..
15	Alec M. ...	Mr. Lawford..	Yes	Scleral incision. Small magnet failed	Excision.....
16	Jacob K....	Mr. Lang	Yes	Small magnet unsuccessful...	Excision.....
17	Fred. Y. ...	Mr. Tay.....	Yes	Scleral incision. Small magnet	Excision .....
18	Wm. S.	Mr. Silcock...	Yes	Scleral incision. Small magnet	Excision.....
				Case in which the Small Magnet failed	
	Alec M. ...	Mr. Lawford .	Yes	Scleral incision. Small magnet failed	Excision.....

Localisation. (*In Vitreous only.*)

Site of f. b.	Vision.	Remarks.
Vitreous	6/9 J 1	Seen 2 years after operation. Operation 14 days after injury.
Vitreous	6/9	Operation 10 days after injury.
Vitreous	6/9 J 1	Injury some days before operation. F. b. seen ophthalmoscopically. V. taken 3 years after operation.
Vitreous	6/36	Posterior polar opacity now present, 2 years after operation. Immediately after operation V. = 6/9. Operation day after injury.
Vitreous	$\bar{c}$ correction 5/60	External rectus paralysed, dense capsular membrane. Injury 4 weeks before operation.
Vitreous	Counts fingers at 1 metre	Traumatic cataract is present.
Vitreous	$\bar{c}$ correction 6/60	Injury 4 months before operation.
Vitreous	$\bar{c}$ correction < 6/60	Aphakia. Thick capsular membrane. Patient was seen 2 years after accident. Operation on day of injury.
Vitreous	P.L.	Seen 4 years after accident. Retina detached Injury 3 days before operation.
Vitreous	Hand movements.....	Injury 8 days before operation.
Vitreous	Counts fingers at 1 metre	Seen 2 years after operation. Lens has absorbed, thickened capsule alone remains.
In coats of eyeball	Hand movements.....	Haab's magnet tried before localisation of f. b. After localisation, site of f. b. cut down upon and f. b. found in coats of globe. Injury 18 months before operation.
Vitreous	P. L.	Seen 3 years after accident. Projection bad. T. −. Injury 8 days before operation.
Retina...	Eye saved	F. b. seen ophthalmoscopically. Injury 3 days before operation.
Vitreous	..	F. b. found in globe.
Vitreous	..	Injury 12 days before magnet operation.
Vitreous	..	Accident 12 days before operation. Sympathetic ophthalmia resulted, causing vision in uninjured eye to fall from 6/6 to 6/24.
Vitreous	..	Seen first 14 days after accident.
to remove f. b. from Vitreous.		
Vitreous	..	F. b. found in excised globe.

of the results after using Haab's magnet is very much better than after using the small magnet.

It is interesting to compare the results obtained by the use of Haab's magnet after X-ray localisation with those obtained by the use of the small magnet after X-ray localisation.

The foregoing list of cases comprises all those treated at Moorfields, up to the end of July, 1901, in which f. b.'s have been removed by the small magnet after localisation by X-rays or the ophthalmoscope.

For the calculation of percentages the number of cases that I have been able to collect is really too small; but at any rate some idea may be obtained from them as to the respective value of the two magnets.

Until I compiled these tables I was of the opinion, from practical experience of the use of the two magnets, that the Haab's magnet results would entirely overwhelm those of the small magnet. This, however, is not the case. There are, nevertheless, several reasons why the Haab's magnet results do not appear so good from statistics as they really are in practice.

(1) In several of the Haab's magnet cases the eye had been so much damaged by the entrance of the f. b. that one could not hope to preserve it as a useful organ. In the small magnet cases the injury was, as a rule, slighter.

(2) As a general rule a longer period between the date of injury and the date of operation had elapsed in the small magnet cases than in the Haab's magnet cases.

(3) Statistics do not show one great value of Haab's magnet, which is, that if a f. b. is present in the vitreous it can almost surely be removed *viâ* the pupillary area by the magnet. This cannot always be done by the small magnet.

Method of using Haab's Magnet.

In using the Haab's magnet the patient is seated on a stool with the injured eye on the same level as the pole of

the magnet, and at a distance of about a yard from it. The current is then switched on at its minimum strength, and the patient is approached to the magnet until the injured globe is almost touching the magnet terminal. The current is then gradually increased to the maximum or until the f. b. gives evidence of its presence, either by appearing in the a. c. or by bulging forwards the iris at some point. If the f. b. has been localised it is possible to so direct its course by varying the position of the injured eye (thereby altering the relative position of magnet terminal, f. b., and structures of the globe), as to avoid injury during the exit of the f. b. While it is often necessary to use the full strength of the magnet in order to start the f. b. from its resting-place in the globe, it is generally best to diminish the current as soon as a certain momentum has been established, or as soon as the iris has bulged. This is especially the case where, owing to the lens being unwounded, it is impossible to direct the f. b. directly into the pupillary area. The reason for diminishing the current is that the less the momentum of the f. b. the less chance is there of the f. b. becoming entangled in the iris. If, in spite of these precautions, entanglement in the iris does occur, the current should be broken, and having directed the force of the magnet in such a way as to avoid the obstacle, it should be made again, using the minimum current.

I will now suppose that the f. b. has been drawn into the a. c.; the next step is to remove it thence. If there is a recent wound, the obvious thing to do is to remove it by that outlet.

If the wound has healed, or if the original wound of entrance was through the sclerotic, a corneal section must be made. This can be made either peripherally or nearer the centre of the cornea. When a peripheral section is made, the patient is placed on the operating table, and a keratome is used for the operation; the f. b. is removed from the a. c. by the small magnet. When the more central section is made, a Graefe's knife is used, the surgeon standing behind

the patient, who sits in a chair in front of Haab's magnet. The f. b. is then removed by the same magnet.

The peripheral incision is that more usually employed at Moorfields. The only inconvenience about it is that it necessitates the use of the small magnet, which is a somewhat clumsy instrument, and the use of which implies the multiplication of instruments. The advantage of the method is that the patient is already lying on the table prepared for any further operative procedure, such as iridectomy of prolapsed iris, &c.

In favour of the more central section it may be said that two instruments only are used in contact with the eye ; one is the terminal of the magnet, which has of course been boiled, and the other is the Graefe knife—speculum and fixation forceps being dispensed with. Again, the terminal of Haab's magnet need not usually be made to quite touch the eye.

In some cases it is impossible to attract the f. b. into the a. c. at all. The cause of this may be one of several conditions :—

(*a*) Entanglement of f. b. in iris or ciliary body.

(*b*) Entanglement of f. b. in coats of injured eye.

(*c*) The large size of the f. b.

In these cases a scleral incision must be made and the terminal of the magnet approximated to the gap produced. Haab's magnet should, at any rate, be tried first of all, for its terminal need not be introduced into the vitreous, whereas the terminal of the small magnet must be inserted between the lips of the wound, much disturbance of the vitreous being thereby produced.

In connection with the above operative procedures, it may be mentioned that subsequent operations for visual purposes on the eye in the cases of extraction of f. b.'s of Haab's magnet have been uniformly successful when they have been performed at a date some months after the primary operation.